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LEONARD W. WING, EDITOR

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GLOBAL PATTERN

OF 4.222-YEAR CYCLES IN TEMPERATURE

by LEONARD W. WING

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A VERY great amount of confusion and misunderstanding has arisen over the years on the subject of weather cycles. Part of this stems from a lack of concerted studies upon cycles—weather or otherwise. Part arises from the highly complicated nature of cycles—weather or otherwise. Part arises from the low amplitude of weather cycles and the consequent inability of many cycles to stand out from among their fellows or from amidst possible random changes. All the other attributes of cycles and weather contribute each its own bit until, with some justification, weather fluctuations have been considered as of a chaotic nature.

The study here reported originated as an exploration into the length, timing, and rhythm of the influx of Pine Grosbeaks into northern United States. In popular belief, the *invasions* or *flight years* occur at about four-year intervals.

Cycles of about 4-years length have long been known for animal life of the Arctic and sometimes elsewhere. Bird students, for example, have long been aware that flight years of the Snowy Owl and Northern Shrike occur at intervals of about four years. Belief in an emmigration of Lemmings at 4-year intervals is well established in the lore of Scandinavia. In the New World Arctic, the rise and decline of Lemmings follows a similar pattern. Whether it is synchronous with the Old

World is not clear. To the "ebb and flow" of Lemming life is attributed the rise and fall of several dependant animals at four-year intervals--such as the Snowy Owl and Arctic Fox. But this relationship has yet to be studied.

Having been interested in these cyclic events in nature for a long time and being particularly intrigued by the influx of Pine Grosbeaks in some winters, several of which I have witnessed, I picked the Pine Grosbeak flight years as the place to begin a study of the 4-year cycle complex in the Arctic.

Though experience with cycles teaches one not to be surprised any longer if an apparently simple cycle proves part of a more complicated situation, I was not at all prepared by previous experience for just how complicated the 4-year range seems to be. But in this complex clearly appears orderly processes. The mysteries connected therewith are largely a product of our own ignorance of the full nature of cycles.

The flight years have been noted by observers in the Lake States (Minnesota, Wisconsin, Michigan, Illinois, Indiana, Ohio, and Ontario) for a great many years. Some years ago, and for the purposes of another study, I tabulated out of the more formal literature the year by year reports of Pine Grosbeak invasions in the Lake States. This showed rather clearly that common knowledge was justified in its estimate of the situation, namely—an influx of Pine Grosbeaks at about 4-year intervals. But several variations from a true 4-year pattern occur and some gaps

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also occur in the record of winters reported: 1870-1871, 1875-1876, 1878-1879, 1880-1881, 1888-1889, 1896-1897, 1903-1904, 1908-1909, 1913-1914, 1915-1916, 1921-1922, 1925-1926, 1929-1930, 1933-1934, 1939-1940. A flight in the winter of 1951-1952 has also been reported.

The information on flight years resembles in one way data for many another time series in nature: amplitude is missing. Hence, one cannot use the usual tools of cycle analysis, such as the moving average, deviations from the moving average, or the periodic table. Among data of this nature may be mentioned years of flood, drought, or insect outbreak, all common events of history. In some ways, these resemble the appearance of cycles with only the peaks showing through to indicate *highs*.

It occurred to me that a time chart might be used if one assumed that occurrence of the Pine Grosbeaks marked a high or peak year, irrespective of what the flight years mean biologically. An influx of birds for the purposes here used is thus a high by definition; it may not necessarily be one in the wild. But the absence of birds cannot be called a low, for they were often absent for several years. Therefore, I set up hypothetical lows as the year two years before or after each high. Though one can make a time chart of highs only, having both highs and lows (the latter hypothetical and based entirely on the former in this case) makes a more complete time chart. This I did (top section, Figure 1).

An axiom among cycle analysts is that when a band of highs or lows on a time chart jumps about half the time-chart interval, a reversing cycle is suspect. The highs of the Pine Grosbeak flight years make such an apparent jump at about the 1882, 1910, and 1938 intervals of a 4-year time chart. But without lows, one cannot determine whether or not a band of highs runs into a band of lows (and vice versa), the habit of a reversing cycle. But the addition of the hypothetical lows indicates rather clearly that the flight year pattern, popularly called a 4-year cycle, is indeed a reversing cycle. The reversal points appear to be as indicated by the three stars in Figure 1, top chart.

If so, the number of intervals between the reversal points would be seven and a half. From this information, it may be possible to fix upon cycle lengths that can be responsible for the indicated behavior of the flight years.

To do this, it is necessary to determine the length of the reversing cycle. (This length is sometimes called the "false length") Because the bands of the reversing cycle rise to the right, the false length is necessarily *shorter* than the 4-year interval of the time chart. Were it the same, the bands would be exactly horizontal.

I fitted straight lines to the reversing bands, as may be seen in Figure 1. The fitted line of the lower band crosses the zero position of the time chart between the 1870 and 1874 intervals; it crosses the minus-one position between the 1934 and 1938 intervals. Arrows on Figure 1 indicate these apparent crossing points. They are sixteen intervals apart. The rise of the line one year (from position zero to position minus-one) in sixteen intervals indicates that the false length is one-sixteenth of a year shorter than the intervals of the time chart. This gives the length of the reversing cycles as 3.94-years (4.00 years less 0.06 years).

With these measurements at hand, it becomes possible to determine the two apparent components of the 3.94-year reversing cycle. The procedure I have outlined before (*Journal of Cycle Research*, 1953, 2:28-51). The computation for the Pine Grosbeak reversing cycle is as follows:

Reversing length: 3.94 years (47.28 months)

Synodic period: $7\frac{1}{2}$ intervals or 29.56 years ($3.94 \times 7\frac{1}{2}$)

Double synodic period: 59.10 years

Double synodic period divided by double number of intervals plus one $\frac{59.10}{16} = 3.69$

(44.33 months)

Double synodic period divided by double number of intervals minus one $\frac{59.10}{16} = 4.22$

(50.65 months)

With these two lengths in mind, I made two additional 4-year time charts (Figure 1, middle and bottom). On one I drew a line with a slope to indicate a length of 3.69

years, on the other, a slope of 4.22 years. If the data have cycles of these lengths, the highs should form bands along these lines. It is obvious that the highs do so, which indicates rather strongly that cycles of these two lengths are possibilities both real and present. Because the data lack amplitude, they can do no more at this point than to suggest the reality of cycles of these lengths.

In any event, either length if of a true cycle could hardly be an internal one to the Pine Grosbeak or hardly to its population complex. The brief life of the bird militates against the possibility. Hence, it would seem that some environmental cycles are involved—unless the fluctuations are of random origin. In order to examine the environment to see what if anything might have a cycle of this length, I chose the longer (4.22 years) of the two for further study and rounded it off at $4\frac{1}{4}$ years (51.00 months). Had I known then of the closeness of cycles in the 4-year range I would not have used a rounded-off figure, which would have saved a great deal of extra work.

Initial tests were run upon the freezing and thawing dates of the Yukon River at Dawson, Yukon Territory, and the Peace River at Peace River, Alberta. Cycles in the $4\frac{1}{4}$ -year range shows up in each series. Then I tested temperature records at Dawson and later at Edmonton, Alberta. Because of the low amplitude of cycles in the $4\frac{1}{4}$ -year range, and shortness of the records, it was necessary to measure as closely as possible the apparent nearby cycles and to adjust the data for them. This technique is often used in cycle analysis and is sometimes called "carving out" of a cycle. A cycle in the $4\frac{1}{4}$ -year length appeared in all temperature records used. Later I tried rainfall and barometric pressure with similar results.

I tested also a few stations farther removed—Chicago, Illinois, and Buenos Aires, Argentina, for example. These indicated a cycle in the $4\frac{1}{4}$ -year range. It suggested that the cycle originally indicated for the Pine Grosbeak might be universal in the New World weather, perhaps also elsewhere.

But the shortness of temperature records, few of them longer than a few score years, makes it impossible to measure the length, with sufficient precision for accu-

rate work.

Because this paper concerns itself mainly with the global pattern of the 4.222-year cycle in temperature, I shall not go into the detailed material that lead to the conclusion that a 4.222-year cycle was a real rhythm. As it forms patterns in so many different events, judgement of its reality seems confirmed. But it will be appropriate to consider steps that established the cycle length initially suggested by the Pine Grosbeak as of 4.222-years length rather than $4\frac{1}{4}$ -years.

I took the longest record that I could find for the Pine Grosbeak country, a 570-year series of measurements of glacial varves at Steep Rock Lake, Ontario.* Deviations from the 5-year moving average of the logarithms of the measurements when thrown into a 4.22-year periodic table (Table 1) indicated that the length was slightly more than 4.22-years, perhaps 0.002 years longer (Figure 2). This is measured by the slippage of the epochs in the second half of the periodic table with reference to the first half. But the 135 sections of 4.22-years length will not give a precision greater than ± 0.003 , there being 62 sections between the central positions of the two parts of the table. A slippage would probably be recognizable to about 0.2 years (hence, $0.2 \div 62 = 0.003$). The probable length is indicated as 4.222. (Table 1, Figure 2).

Though the varve record comes from the Pine Grosbeck country, it is of Pleistocene time, a hundred or so centuries ago. It indicates, however, that a cycle in the length being measured probably has not changed measurably in a long time. Or if it has changed, has done so in a way to give the appearance of little, if any, change.

Not having any longer records of current time for the Northland, I went farther afield and used measurements of the last thousand years of tree rings at Lukachukai, Arizona (actually 1,044 years, 896 A.D.--1939 A.D.)** In order to prepare them for most efficient study in the four-year

*ANTEVS, ERNST. "GLACIAL CLAYS IN STEEP ROCK LAKE, ONTARIO, CANADA." *Bulletin of The Geological Society of America*, VOL. 62. PP. 1223-1262, OCTOBER 1951.

**MEASUREMENTS BY HAROLD GLADWIN FROM *Cycles--A Monthly Report*, MAY, 1951.

range, I converted the data to logarithms (as previously for weather, freezing, thawing, and varve data), made a five-year moving average, and obtained the deviations from this moving average trend. A 4.221-year periodic table (Table 2) made from these and graphed by halves (Figure 3) shows a slippage of about 0.001 years, which indicates that the cycle length is 4.222-years. Within the limits of precision, the varves and tree rings agree, so I take 4.222-years as the best representation of the cycle length.

It may be well at this point to review the practice used for determining the ideal time of high or low of any cycle of 4.222-years length in a time series. For this purpose, the data of Tables 3 and 4 (Yukon tree rings) will be used. The data of Table 4 are the deviations of logarithms of the tree-ring widths from their 5-year moving average as prepared in Table 3. Hence, they are the logarithms of the percentage of the 5-year moving average trend.

One may use conveniently the arithmetic average, the median, or the average median for each column in the 4.222-year periodic table, choice depending upon the length of the periodic table and number of apparent "distortions". (That is, distortions so far as any 4.222-year cycle is concerned.) If many apparent, strong distortions are present in the several sections making up the table, one may advantageously compute new values according to the *principle of limited data* and use this set of limited values. The column averages or medians are graphed as in Figure 4, the graphing being repeated in a second run as shown.

Several graphical methods may be used and one must be chosen for determining the position of the average high or average low in the periodic table. Because of the simplicity involved, I use the midpoints between the crossings by the curve of its own axis. Its axis for this purpose is the line determined by a point half-way between the highest and lowest amplitudes. For the 4.222-year length, I use the original curve or a centered graphical 2-year moving average (a 2-year moving average of a 2-year moving average). Choice of original or smoothed curve rests upon time available. If the original curve is rather uniform in shape, the resulting determinations of high

or low will be practically the same, whether the original or a smoothed curve is used. I determine the midpoint of one epoch, either the high or low, from the graph and subtract (or add) half a cycle length (2.111 years) to get the other, even though we do not know if the rise and fall of the cycle is symmetrical.

Because I use a standardized base year for all 4.222-year periodic tables (except a few made at an earlier date), the respective columns always represent the same years. The respective points on the curves represent the corresponding columns and therefore fixed years after the base years. As the latest whole year is 1934.000, succeeding base years will be 1938.222, 1942.444, 1946.666, 1950.888, 1955.110, and 1959.332. The position of the midpoint of the curve as graphed from the periodic table added to a base year gives a mathematical rendition of the corresponding ideal time of high or low, respectively. Added to the most current base year, it gives the current time of ideal high or low.

In Figure 4, the axis of the original curve is at log. 2.0093. That of the centered 2-year smoothed curve is at about log. 2.0035. For the latter, the two points where the low phase of the curve crosses its own axis are base year plus 3.840 and base year plus 6.080 (the latter in the second run of the curve). This gives the midpoint of the low as at 4.960. The current time of ideal low is therefore $1950.888 + 4.960 = 1055.848$. To this must be added a half year to plot at mid-year, which makes 1956.348 (0.348 years after January 1, 1956). This gives May 7, 1956 as the calendar date for this mathematical rendering of the current time of ideal low. The current time of ideal high would be 2.111 years earlier or March 7, 1954. The practice of using the current time of ideal high or low makes it possible to use a standard practice in comparing epochs.

T R E E R I N G S

Though the tree ring measurements here recounted actually were done at different times and often sandwiched between some of the temperature records reported later, the tree rings will be considered as a unit.

Yukon Tree Rings. In the summer of 1948,

I cut sections from some spruce trees in Yukon Territory, near Johnson's Crossing of the Teslin River at about 60° North Latitude. Mr. Carl Thomas, then a senior student at the Agricultural and Mechanical College of Texas, College Station, Texas, measured the tree rings. From the longest record, (1773-1942, 170 years) I prepared deviations from a 5-year moving average (Table 3). A 4.222-year periodic table (Table 4) and a graph (Figure 4) have already been mentioned. The low amplitude of any cycles in the 4-year range in temperature and other events makes it difficult to isolate a clear rhythm with the tools presently available for cycle analysis. Part of the difficulty arises also from the evident closeness of cycles, perhaps but 1% or less apart in the 4-year range. But if the periodic table does indicate any cycle of 4.222-years as present, its ideal time of high will be about as indicated. We shall see later that this fits into a global pattern, which fact adds strong argument for the presence of a rhythm averaging 4.222-years during the 171 years (40 sections) of the record, even though actual isolation cannot be obtained clearly.

Alaska Tree Rings. A number of Alaska tree rings have been measured and reported. In fact, western North America is particularly fortunate in having tree ring records available from widely scattered places. The longest "farthest north" one that I could find is a spruce at Nulato, Alaska* (about 64° 45' N.). The data (1800-1947) in deviations from a 5-year moving average are shown for a 4.222-year periodic table in Table 5 and Figure 5. The current time of ideal high falls on July 12, 1954, that of the low on August 21, 1956.

British Columbia Tree Rings. A 525-year record (1420-1944) from British Columbia (about 56° North) is given as a "percentage of the general trend in growth."** The 124 sections in a 4.222-year periodic table (Table 6, Figure 6) indicate a current time of ideal high at April 26, 1956 and of a low at March 17, 1944. The epochs, however, are opposite to those of the Yukon, Vermont, and Alaska measurements.

The periodic table shows an extra high and low (Figure 6), which perhaps indicates that the measurements are from a place near or in the cross-over zone between correspondence with temperature highs and lows. Cross-over zones appear in other biological data of wide latitudinal distribution, so that their appearance here should not be unexpected.

Vermont Tree Rings. A series of hemlock measurements (1544-1934, 391 years) at Fairlee, Vermont* (about 43° N.) have been prepared as deviations from a 5-year moving average of the logarithms (Table 7 and Figure 7). The current time of ideal high falls at January 28, 1955 and that of the low at December 19, 1952.

Pennsylvania Tree Rings. A series of hemlock rings (1703-1939, 237 years) near Sheffield, Warren County, Pennsylvania (about 41° 45' N.) have been published as percentage of the mean.** Hence, the data are not of a moving average and various cycles have not been minimized or otherwise manipulated. The current time of ideal high falls on February 24, 1953, that of the low on April 6, 1955.

Arizona Tree Rings. The long record of tree rings from Lukachukai, Arizona (about 36° N.) have been described already (Table 2 and Figure 3). Contrary to the other records, the Lukachukai record has been built from a number of overlapping records of ponderosa pine trees. Cross-dating of such trees always raises questions of correctly determining the corresponding years. Differences in ring growth between trees and during different parts of the life spans complicate amplitude, though some compensation for these factors can be made as each new tree joins the record. The current ideal time of high falls on July 18, 1952 and the low on August 26, 1954.

Java Tree Rings. A teak record (1515-1929, 415 years) from Java (about 6° S) extends the series into the Southern Hemisphere*** In the tropics as elsewhere, just what the ring changes from year to year represent is a matter of uncertainty. But

*TREE RING BULLETIN, 16: 26-30.

**TREE RING BULLETIN, 13: 10-24.

*SMITHSONIAN MISCELLANEOUS COLLECTIONS, VOL. 95, NO. 19.

**TREE RING BULLETIN, 7: 20-26.

***KONINKL NEDERLAND AKADEMIE VAN WETENSCHAPEN, SERIES B, 55: 386-394.

the appearance of the 4.222-year pattern seems definite (Table 9, Figure 9). The current time of ideal high falls on March 10, 1954 and that of the low on January 28, 1952.

Southwest Africa Tree Rings. A report of tree ring measurements in Southwest Africa resulted in correspondence with Dr. W. Huss of Struttgart, who measured the rings. As near as I am able to determine, the site is at about 23°S. A graph supplied to me made it possible to determine the relative year to year variations of the rings by reading off the graph, original data being unavailable. I chose the longest record (Karakuwisa, 1679-1864). The current time of ideal high (twenty sections beyond the last base year) falls at August 22, 1952, that of the low at November 7, 1954.

TEMPERATURE RECORDS

As mentioned earlier, a cycle in the $4\frac{1}{4}$ year range appeared evident in temperature records from such places as Dawson, Edmonton, Chicago, and Buenos Aires. Hence, I decided to see if this might be a cycle of 4.222-years length and if it might be present and traceable on a global basis. For this, I decided to use a hundred stations from all continents. The stations were taken from *World Weather Records** by checking off stations in the index as nearly as possible to ten degrees apart in longitude and five degrees apart in latitude. The dropping of several stations with records making fewer than ten sections in the periodic tables (except in high latitudes and a few other regions of scarce data) left only 95 stations. Afterwards, a gap in western Africa was noted and Freetown in Sierra Leon and Gibraltar on the Mediterranean added. The latter data were used directly, not as percentages (as logarithms) of a moving average trend.

Some interpolations for missing data were found necessary in some records. Where only a month or so was missing in a year, I substituted the period mean (monthly) for the missing month and used the resulting twelve full months to compute a yearly value. In years of more missing months, I

interpolated a yearly value from the existing yearly ones. In most Russian records, the values for 1916 to 1921 were missing. In order to continue the moving average across the gap, I entered the period yearly mean for the missing years. While interpolation or substitution of data always introduces complications, the problem of missing data must be faced always and the resulting difficulties recognized. Otherwise, many series cannot be used, and great geographic areas must be omitted. Hence, one must adopt a "practical" attitude until some better approach can be devised.

Phase Charts. Because the records are all short, the longest being but a few score years, demonstration of an actual rhythm of 4.222-years is practically ruled out with the low amplitude of temperature cycles. But an indirect method of demonstrating and detecting a rhythm exists in the *phase chart*.

The latitudinal phase chart plots latitude as the ordinate against time as the abscissa. Other phase charts can be constructed from appropriate ordinal elements, such as longitude. (No pattern was found by use of a longitudinal phase chart.) In place of geographic latitude, one can use magnetic elements (e.g., magnetic latitude, horizontal intensity, or vertical intensity of magnetism).

The time of ideal high, when plotted from a periodic table has any of 50.664 months (i.e., 4.222 years) in which to fall. Thus when stations from all over the World are plotted on the same phase chart, and using the same base year, the plotted points have equal opportunity for wide dispersal. But if there is a cycle present, the plotted points will take on a pattern rather than be at random. If the cycle has a rhythm occurring simultaneously everywhere, the plotted points will show a vertical banding or zoning at the time of ideal high (or low), the epoch being the same for all latitudes, longitudes, or other component being used as the ordinate. But if there is no cycle or no relationship to the element used as the ordinate, the plotted points will have a random distribution over the 50.664 months. Departure from random distribution indicates presence of a gross rhythm, even though it could not be demonstrated or identified in the origi-

*SMITHSONIAN MISCELLANEOUS COLLECTIONS, VOLS. 79, 90, 105.

nal data, its amplitude being so low. This seems to be the case with weather cycles of low amplitude.

Temperature Epochs of the 4.222-year Cycle. In order to prepare the world-wide data mentioned previously, I set up periodic tables as described, using the standard base years pattern so that the most recent section in the temperature series had base year 1934.000. Because the 5-year moving average loses two years at each end, the final base year of 1934.000 makes the final section complete. (Most weather data ended in 1940.) Any partial sections will be at the beginning of the record, the years when data presumably would be least well recorded. Hence, partial sections omitted from column averages would be the earlier years; in practice, I prefer to use only complete sections.

While the use of the standard base years makes for convenience, it is not essential and does not influence the results. A different set of base years would merely take a mathematical adjustment. One ending 1933.000 would have an adjustment of one year to match a 1934.000 base year. One ending 1933.666 would have an adjustment of 0.334, etc. If one determines the calendar time of ideal high before making comparisons of epochs, base-year adjustments will not be needed.

The temperature data as deviations of logarithms from their 5-year moving average were entered in periodic tables and appropriate means or average medians made for each table (Appendix I). The current time of ideal high (or low) was then obtained by graphing (Appendix II) the appropriate means or medians as explained previously. The current time of ideal high or low, therefore, is the time that a high or low of any 4.222-year cycle would appear in the table if present in the data. Thus, it is subject to any random distortions, errors, or omissions in the data, any systematic errors of recording or handling the data, and the distorting influence of any other cycles present. The latter influence would be greater for cycles near 4.222-years than longer ones, because the 5-year moving averages minimizes the longer cycles.

Table 11 presents a summary of the points of high and low in the respective

tables and current times of high and low as projected forward from the base year 1934.000. It presents also a summary of the data.

Using the current time of ideal low, I constructed a 4.222-year (50.664-month) latitudinal phase chart (Figure 11). It shows some previously unrevealed tendencies of weather, tendencies that seemingly cannot be revealed by other existing methods of analysis. The phase chart shows an unmistakably clear pattern of behavior for the weather in respect to any 4.222-year cycle. The recognizable pattern demonstrates rather strongly that a rhythm of 4.222-years is present in temperature. It demonstrates also that the 4.222-year cycle makes a global pattern and that the global pattern has a plainly visible slippage from high latitudes to low latitudes, simultaneously in both hemispheres. I fitted a straight line to the data for the Northern Hemisphere and another of the same slope for the Southern Hemisphere (heavy line in Figure 11).

A few variations from the pattern occur, as at Upernivik (2), Bushire (41), Honolulu (46), and St. Helena (68). A number of stations in the Southern Hemisphere show a pattern of latitudinal acceleration that cannot be interpreted at this time. Thus the current time of ideal low at Punta Arenas (93) is placed at October 11, 1952. The ideal time for a station at this latitude ($53^{\circ} 10' S.$) as indicated by the main band of the lows is about at the end of March 1954. Thus the indicated time of low for Punta Arenas has been accelerated by about a year and a half. Its indicated time actually is the time of ideal low for about $90^{\circ} S.$, presuming of course that the behavior shown within the range of weather stations continues poleward beyond.

Some of the variation in time of ideal low timing may reflect merely the short records and consequent weak leverage of the few sections involved. Preliminary observations, however, indicate that pattern may be present in the acceleration and retardation of the ideal timing.

Though the data of Figure 11 reach only to Greenland in the Arctic and to the South Orkneys in the Antarctic, the lows make such a clear band as to suggest that the band would continue poleward if polar data

were available. The straight-line trend of the band has been drawn to indicate this possibility. We can interpret the "butterfly" appearance of the line thus extended as indicating that an epoch appears first at the poles and progresses equatorward, simultaneously in both hemispheres. But before it disappears at the Equator, the next epoch (of opposite phase) has already made its appearance in the polar regions. The low of the 4.222-year cycle in temperature would seem to have appeared at the poles in late December 1952, to disappear at the Equator in late January 1956, an interval of about thirty-six months. On the original work sheet (ruled five lines to the inch) from which Figure 11 was prepared, the crossing points at the 90° and 0° lines measured 35.8 months apart. The slippage would therefore be 70.7% of the length of the cycle ($35.8 \div 50.664$). To express it the other way, the cycle of 50.664 months is 142% of the slippage ($50.664 \div 35.8$).

If the behavior runs from the Poles to the Equator, which the phase chart indicates that it does, the wave would progress equatorward at the rate of about four months for each ten degrees of latitude. In terms of miles and days, it would be about $11\frac{1}{2}$ miles a day or a little less than half mile an hour. (This should not be confused, however, with passage of air masses, something entirely different from cycle slippage.) Preliminary work with the few other cycles measured with some precision suggests most strongly that they behave the same way. The relationship of slippage to cycle length is the same--that is, 70.7% of the cycle length. The slippage of the 4.418 cycle, for example, appears to take about $37\frac{1}{2}$ months if from pole to pole (Figure 12). The slippage and slippageratio may therefore be related in some way to the sphere and its geometry.

While I have used a straight line fitted to the data of Figure 11, it may well be that a larger number of stations on the chart would modify the pattern somewhat. It may be--and there are reasons to think that it could be--that with more data in the various latitudes, especially the very high and very low ones, the line on the latitudinal phase chart would take on a sigmoid shape.

Tree Rings and the Phase Chart. I deter-

mined current time of ideal high for the tree rings as indicated by the several periodic tables and their graphs. These have been added to the temperature phase chart by means of lettered symbols, open for the low and filled for the high. The tree ring epochs of the 4.222-year cycle fall into the pattern of the temperature data. In fact, they lend very strong support for the reality of the behavior pattern. They fall into an even narrower pattern of latitudinal slippage, irrespective of the length of the record, the place where found, or species of tree. The light, dashed line of Figure 11 has been fitted to the tree-ring data. The X at 6° North Latitude marks the position north of the Equator corresponding to that of Java tree rings (6° S.) south of the Equator. The tendency for narrowing of the spread with longer records appears to exist also in the temperature records.

Calendar Years. The temperatures have been recorded by calendar years, and the base year has been adjusted so that the yearly data plot at midyear, the customary practice. But just how to relate the tree rings to the calendar is a problem related to the growth year, which is related both to the life habits of the tree and the geography of its site. As the temperature data are by calendar years, no adjustment between the two hemispheres is necessary. The 4.222-year cycle is not a seasonal one. But the growth of the tree in the respective hemispheres depends upon season. In the Southern Hemisphere, the tree ring marks a single growth year but parts of two calendar years. The position of K (Southwest Africa) and J (Java) should perhaps be moved six months. The same problem arises in trying to relate cycle timing of many biological events to the calendar. I have not tried to do this for the tree rings or for animals because I know of no workable formula. The tree ring slippage of Figure 11 seems to lag about five months behind that of temperature. Perhaps this indicates a possible order of adjustment.

The fact that epochs in the northern tree rings differ from those of more southern ones is perhaps related to some other environmental factor than temperature. Such behavior, particularly crossing over, ap-

pears also in date of other organisms, which is not altogether unexpected.

S U M M A R Y

A study of flight years of the Pine Grosbeak into the Lake States, commonly believed to be at 4-year intervals reveals that it is a 3.94-year reversing cycle. One component of 4.222-years length has been used for an intensive study of global pattern in temperature. Tree rings showed a similar pattern.

The 4.222-year cycle measured the same in a 570-year Pleistocene varve record from Ontario.

The current time of ideal high and low was determined for each of 97 stations dis-

tributed over all continents. Lows were plotted on a latitudinal phase chart and showed a "butterfly" pattern.

The epochs of the 4.222-year cycle appears first in polar regions, presumably at the respective Poles, and slips equatorward simultaneously in both hemispheres. The slippage measures 70.7% of the length of the cycle.

Other cycles seem to behave the same way and to have a slippage of the same proportion.

Irrespective of length of the record, fewer than thirty years for some stations and 1,044 years for tree rings, the epochs, all treated alike, fall into a global pattern.

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NOTE: Most of the tables and figures, as well as the appendices have been reproduced from the original work sheets.

TABLE I
4.22-year Periodic Table
Glacial Varve

Base year	1	2	3	4	Year	Base year	1	2	3	4	Year	Base	Section average	1	2	3	4
0	2.060	2.124	2.060	1.921		283	1.940	2.036	2.220	1.852							
7	2.134	1.761	1.976	2.076		287	1.851	2.209	1.839	2.020							
8	2.014	2.168	1.927	1.909	1.926	291	2.160	1.934	1.783	2.089							
13	1.949	2.381	1.771	1.764		295	2.201	1.763	2.080	1.749	2.001						
17	1.154	2.004	2.023	2.141		300	2.003	2.081	1.923	2.071							
21	1.716	1.992	1.797	2.268		304	1.912	1.911	2.071	1.937							
25	1.798	2.131	2.010	1.880	2.097	308	2.034	2.124	2.096	1.804							
30	2.139	2.124	1.512	2.061		312	1.945	1.769	2.186	2.186							
34	2.128	1.741	2.248	2.094		316	1.880	1.914	1.970	2.021	2.036	190-376					
38	1.843	1.851	2.000	2.292		321	1.870	1.901	2.090	2.004							
42	1.947	1.867	2.058	2.098		324	1.864	2.167	1.817	1.780							
46	1.951	1.770	2.162	2.113	2.024	329	2.115	1.949	2.112	1.927							
50	1.840	1.959	1.941	2.200		333	1.947	2.010	2.036	1.740	2.073	32-565					
54	2.003	1.791	1.892	2.101		338	1.999	1.712	2.123	2.058							
59	2.061	1.744	1.972	2.202		342	1.764	2.096	2.088	1.936							
63	1.848	1.966	2.004	1.986	1.951	346	1.904	2.106	2.019	1.814							
68	2.116	1.878	2.029	2.047		350	2.122	2.013	2.099	1.783							
72	2.004	1.818	2.114	2.033		354	1.900	2.167	2.065	1.978	1.921	Average by holes					
76	1.943	1.768	1.932	1.922		359	2.146	2.031	1.958	1.793							
80	1.941	2.083	2.005	1.907		363	2.062	2.079	1.987	1.994							
84	2.128	1.858	1.749	1.927	2.109	367	2.065	2.045	1.903	1.823							
89	2.130	2.049	1.850	2.074		371	2.178	1.970	2.113	1.751	2.177						
93	1.990	2.050	2.008	1.882		376	2.102	1.958	1.712	2.148							
97	2.121	2.027	1.873	2.081		380	2.160	2.078	1.885	1.784							
101	2.051	1.860	2.009	1.998	2.031	384	2.100	1.988	1.974	2.127							
106	1.996	1.894	2.053	2.099		388	1.951	2.036	1.911	2.062							
110	1.944	1.835	2.116	2.118		392	1.923	2.110	1.958	1.912	2.150						
114	2.089	1.846	1.975	1.925		397	1.937	2.093	1.863	1.981							
118	2.102	2.112	1.970	1.869		401	2.163	2.057	1.719	2.072							
122	2.087	2.011	1.943	2.150	1.783	405	2.085	2.206	1.918	1.737							
127	2.051	2.140	2.002	1.794		409	2.023	2.066	2.118	1.880	2.036						
131	2.041	2.115	2.118	1.900		414	1.959	1.944	2.023	2.067							
135	1.974	1.886	1.997	2.075		418	1.881	2.183	2.020	2.082							
139	2.084	1.943	1.886	2.113		422	1.740	1.997	2.014	2.068							
143	2.117	1.903	1.919	1.889		426	2.218	1.820	1.950	1.932							
148	2.030	2.204	1.964	1.970	1.970	430	2.016	2.039	2.004	2.079	1.986						
152	2.118	2.027	1.991	2.113		435	2.035	1.953	1.978	1.921							
156	1.811	2.211	2.019	2.005		439	1.942	2.149	1.864	2.062							
160	1.905	2.163	1.951	1.927	2.063	443	2.103	1.799	2.068	2.033							
165	2.115	1.879	1.943	1.997		447	1.986	2.053	2.065	1.940	1.024	90 sections					
169	1.986	2.005	2.029	2.048		452	2.058	2.100	2.063	2.063							
173	2.012	1.983	2.110	1.889		456	1.696	2.084	2.064	1.943							
177	1.970	1.945	2.138	1.826		460	2.065	2.019	2.068	1.988							
181	1.974	2.073	1.954	2.116	1.970	464	1.964	1.894	2.041	1.963							
186	2.002	2.013	1.873	1.929		468	2.139	2.121	1.901	2.004	2.044						
190	2.138	2.097	1.870	1.974		473	1.822	2.120	1.897	2.235							
194	1.989	1.983	2.148	1.916		477	1.806	1.957	2.213	1.953							
198	1.884	2.125	1.976	1.759	1.903	481	2.042	1.862	1.998	2.117							
203	1.877	2.030	1.972	1.996		485	1.866	1.848	1.922	2.284	1.984						
207	1.861	2.093	1.950	2.001		490	1.953	1.974	2.016	2.120							
211	2.034	2.160	1.897	1.922		494	1.828	2.001	2.232	1.970							
215	2.051	1.983	1.918	2.063		498	1.794	1.929	1.999	2.310							
219	2.010	2.000	2.121	2.166	1.563	502	1.859	1.726	2.179	2.107							
224	2.073	2.119	1.950	1.896		506	1.866	2.108	1.864	1.991	2.035						
228	2.144	2.043	1.976	1.862		511	2.112	1.897	2.124	1.931							
232	2.026	2.157	2.045	1.754		515	1.966	2.046	1.870	2.104							
236	1.969	2.170	2.183	1.843	1.925	519	2.029	1.904	1.868	2.127							
241	1.982	2.173	2.001	1.752		523	1.729	1.895	2.094	1.918	2.104						
245	2.088	2.017	2.061	2.066		528	1.899	1.947	2.030	1.938							
249	1.921	1.927	2.009	2.026		532	2.054	1.952	2.102	2.073							
253	2.089	2.044	1.791	1.999		536	2.131	1.715	1.867	2.279							
257	2.124	1.892	2.105	1.914	1.904	540	2.050	1.893	1.897	2.091							
262	2.142	2.136	1.844	1.843		544	2.115	1.942	1.864	2.183	1.880						
266	2.173	2.029	1.808	2.033		548	1.992	1.908	2.107	2.078							
270	2.168	1.819	2.049	2.048		553	1.777	2.107	2.220	1.734							
274	1.871	2.006	1.711	2.074	2.074	557	2.018	2.005	1.973	2.046							
278	1.922	1.981	2.229	1.842		561	2.069	1.992	1.980	1.863							
						565	2.136	1.993	1.944	1.961							

TABLE 2

4.222-Year Periodic Table Luhochukhai Tree Rings

Duration of logarithmic film 5-year moving average

Duration of logarithms from 5-year moving average																		
Base year	years after Base					Base year	years after base					Base year	years after base					
89568	1	2	3	4	4.22		1	2	3	4	4.22		1	2	3	4	4.22	
896	2053	1953	1999	2044		1250	1840	2031	2230	1398	2.213	1605	2031	2032	2004	2024		
900	2062	1890	2158	1801		1255	2367	2179	1033	2446		1609	2001	2066	2098	1943		
904	2365	1889	1834	2109	1903	1259	2297	2067	1944	1678		1613	2107	1698	1999	2231	2163	
909	1839	2247	1879	2032		1263	1908	2184	2071	1914		1618	1879	2127	2239	1938		
913	2172	2116	1869	2100		1267	2083	2034	1830	2054		1622	2103	1945	2146	1948		
917	2166	2128	1813	2274		1271	2239	1949	1796	2382	1689	1626	2177	1941	1984	2218		
921	2190	1972	1845	2291		1276	1945	1799	1720	2251		1630	2004	1722	2223	2081		
925	2171	1945	2159	1990	1821	1280	2155	2146	1642	2044		1634	2050	2128	1762	1884	1971	
930	2101	2069	2018	2043		1284	2388	1760	2091	1976		1639	2099	2129	1930	1844		
934	1944	1983	2001	1991		1288	1892	2440	1866	1940	2120	1643	2087	2046	1943	2304		
938	1883	2003	2153	2054		1293	1880	1903	1869	2106		1647	1679	1995	1960	2076		
942	1881	1911	2049	2085	1997	1297	2327	2409	1974	2180		1651	2195	1933	1862	1928		
947	1847	2094	2154	1888		1301	2075	2020	2012	2384		1655	2241	1901	1854	2071	2078	
951	2089	1993	1926	2101		1305	1977	1866	1979	2142		1660	2001	1999	2075	1967		
955	2344	1936	1861	2062		1309	2360	1864	1995	2194	1872	1664	2056	1807	2075	2333		
959	2086	2030	1937	2013		1314	2070	1923	2046	2136		1668	2445	2448	2338	2314		
963	1943	2010	2074	2101	1823	1318	2172	2116	2230	1822		1672	1999	2448	2338	2314	2207	
968	1927	2112	1983	1947		1322	1679	2127	2107	2230		1677	2079	1977	1992	1981		
972	2353	2212	1942	2030		1326	2083	1798	1682	2169	2154	1681	2134	2244	1914	1553		
976	2209	2044	2135	1713		1331	2055	2144	2116	1930		1685	2116	2184	1945	1991		
980	2058	2139	1958	1710		1335	2127	2301	1712	1912		1689	2033	1951	1999	1951		
984	2046	2145	2101	2026	2146	1339	2008	2001	2108	1960		1693	2101	2115	1873	2070	1932	
989	1974	1950	2127	1857		1343	2016	2091	2066	1634		1698	2073	1797	2242	2116		
993	2005	2018	2129	1854		1347	2138	2367	1662	1621	2108	1702	1901	1790	2136	2209		
997	2080	2046	2155	1743		1351	2398	1929	1691	2105		1706	1946	1665	2134	2151		
1001	2035	2199	2141	1073	2270	1356	2016	2233	2332	1622		1710	1921	1883	2209	1908	1958	
1006	2303	2098	1931	2058		1360	1608	2298	2015	1969		1715	1910	1976	2119	1981		
1010	1939	2093	1940	1826		1364	1946	2079	1972	1984	2063	1719	2149	1938	1884	1942		
1014	2118	1952	2117	2126		1369	2191	1743	1925	2035		1723	1977	2124	2032	2188		
1018	1707	2155	2089	1670		1373	2312	1899	1892	2103		1727	2061	2093	2196	2182		
1022	2123	2185	1979	2062	2049	1377	2231	1313	2184	2268	2154	1731	2084	2136	2056	1962	1793	
1027	2000	2085	1825	2009		1381	2084	1872	1951	2098	2003	1736	2099	2160	1653	2122		
1031	2032	2000	2302	1950		1385	1980	2088	2074	1933	1639	1740	2138	2059	1999	1931		
1035	1944	2142	2118	1964		1390	2075	2184	1870	2131		1744	2101	2224	2101	1662		
1039	2056	1993	1984	2088	1862	1394	2074	1871	2176	1866		1748	2373	2111	1918	1957	1877	
1044	1969	2164	1925	1759		1398	1963	2006	2162	1676		1753	2210	1806	2122	1991		
1048	2207	1918	2001	2123		1402	2049	2130	1932	2057		1757	2093	2225	2080	1956		
1052	1926	1941	2105	1944		1406	2018	2034	2172	1798	1988	1761	2104	2097	2219	2261		
1056	1970	2101	1988	1921		1411	2382	2239	2354	2088		1765	2149	2144	2054	2044		
1060	2007	2094	1840	2067	2134	1415	2001	2137	1874	2094		1769	1874	2054	2248	1790	1957	
1065	2247	1743	1821	2171		1419	2064	1956	1944	1714		1774	2149	2171	1816	1665		
1069	2187	2145	1870	1942		1423	1942	2146	2047	2010	2074	1778	2111	2038	2104	1874		
1073	2002	2019	2036	2003		1428	2050	1970	2199	1926		1782	2145	2023	1620	2135		
1077	1840	2319	1904	1877	2309	1432	2160	2306	1942	1917		1786	2184	1822	2055	1810	2028	
1082	2169	2267	1854	1730		1436	2017	2019	1877	1743		1791	2163	2080	1940	2029		
1086	2253	2158	2402	1332		1440	2393	2067	1947	1935	1826	1795	2061	1892	1914	2078		
1090	2008	2258	1977	2077		1444	1932	2073	2044	1923	1826	1799	2130	1806	2094	1622		
1094	1918	2145	2093	1918		1449	1956	2049	2113	2304		1803	2155	2054	1656	2287		
1098	1808	2144	1926	2116	2083	1453	2163	2307	1897	2120		1807	1881	2007	1951	2067	1988	
1103	1869	2243	2245	1644		1457	2356	2100	1938	2157		1812	2013	1926	2043	2198		
1107	1680	2012	2173	2035		1461	2398	1995	2196	2074	2207	1816	2243	1956	2117	1809		
1111	2142	1813	1822	2049		1466	2092	2293	2125	1700		1820	2191	1714	2095	2095		
1115	2132	2008	2132	2068	1841	1470	2448	2181	2306	2343		1824	2095	2054	1958	2292		
1120	1869	2361	1867	2325		1474	1871	1929	2434	2322		1828	1946	2108	2095	1637	2130	
1124	1917	1929	2013	2260		1478	1859	1942	2107	2190		1833	2047	2114	1938	1980		
1128	2317	2132	1718	1843		1482	1865	2134	2266	1912	1406	1837	2051	2124	1944	1945		
1132	1931	2092	1995	2207		1487	2208	2053	2086	2088		1841	1861	2006	2083	2082		
1136	1890	1939	2276	1913	1880	1491	1891	2168	2135	1637		1845	2159	1944	2108	2107	2038	
1141	2241	1895	1791	2048		1495	2052	1936	2142	2079		1850	2089	1846	1947	1937		
1145	2349	1951	1966	2106		1499	1650	2176	1992	2019	2301	1854	2075	2050	1941	2126		
1149	1889	2025	2025	1905		1504	1944	1659	2091	2133		1858	2103	1992	1945	2340		
1153	2141	2186	1644	2318	1467	1508	2051	1878	1947	1962		1862	2048	1768	2124	1919		
1158	1847	2424	1833	2196		1512	2193	2196	1924	1872		1866	2021	2172	2071	2065	1670	
1162	2256	1755	2075	1997		1516	1816	1863	2222	2132		1871	2006	2066	2103	1844		
1166	2280	2109	2120	2072		1520	2068	1714	1991	1958	2159	1875	2117	1922	2115	1916		
1170	2005	2098	2349	2189	1899	1524	2184	1736	2015	2013		1879	1951	1951	1932	2140		
1174	1854	2275	1893	2087	1899	1528	2184	2137	1954	2153		1883	1949	2002	1981	1940	2102	

TABLE 3
Spruce Tree Ring Sections
Measured in Thousand of a Centimeter

		Johnson's Crossing, Yukon Territory, (61°N)							
Year	X1000	Regeneration	5 year moving average	Month	Year	X1000	Regeneration	Month	Year
1773	66	1.820			55	34	1.551	1.750	1.781
74	60	1.778			1860	18	1.255	1.752	1.503
1775	64	1.806	1.825	1.978	61	98	1.991	1.712	2.279
76	74	1.814	2.055	0.2	92	1.964	1.786	2.178	
77	78	1.869	1.849	2.020	63	62	1.820	1.962	1.904
78	86	1.778	1.882	68	80	1.903	1.908	1.945	
79	90	1.954	1.896	2.058	86	80	1.903	1.930	1.973
80	78	1.892	1.402	1.990	90	1.954	1.964	1.970	
81	108	2.017	1.946	2.071	118	2.072	1.994	2.078	
82	80	1.903	1.457	1.946	122	2.086	1.994	2.112	
83	92	1.964	2.032	1.932	69	90	1.954	1.988	
84	102	2.009	2.015	1.994	1170	60	1.806	1.908	
1785	184	2.205	2.036	2.229	71	82	1.914	2.038	
86	86	1.935	2.026	1.969	75	54	1.732	1.851	
87	102	2.009	1.998	2.011	94	1.973	1.918	2.055	
88	82	1.914	1.945	1.969	70	96	1.982	2.046	
89	74	1.869	1.962	1.907	1805	98	1.991	2.034	
1790	100	2.000	1.981	2.019	76	100	2.000	2.071	
91	100	2.017	2.034	1.939	77	69	1.939	1.919	
92	128	2.107	2.050	2.057	78	68	1.833	1.905	
93	106	2.025	2.026	1.999	189	86	1.905	1.996	
94	126	2.100	2.028	2.072	180	108	2.033	1.962	
1795	76	1.881	2.018	1.863	81	114	2.057	2.043	
96	106	2.025	2.025	2.000	82	90	1.944	1.978	
97	114	2.057	2.033	2.024	83	122	2.086	1.956	
98	116	2.064	2.085	1.976	84	56	1.784	1.977	
99	138	2.140	2.128	2.012	1805	86	1.935	1.974	
1800	142	2.152	2.132	2.020	136	136	2.134	1.948	
01	170	2.230	2.172	2.058	87	80	1.903	2.004	
02	118	2.072	2.144	1.928	102	102	2.009	1.993	
03	184	2.265	2.206	2.059	89	110	2.041	1.974	
04	100	2.000	2.207	1.793	1890	98	1.991	1.974	
1805	270	2.462	2.219	2.243	91	84	1.924	1.956	
06	172	2.236	2.208	2.028	80	1.903	1.892	2.011	
07	136	2.134	2.263	1.871	84	1.924	1.814	2.110	
08	162	2.210	2.231	1.979	90	52	1.716	1.932	
09	188	2.274	2.201	2.073	1895	40	1.602	1.788	
10	200	2.301	2.188	2.113	86	60	1.778	1.744	
11	122	2.086	2.184	1.902	87	84	1.924	1.800	
12	118	2.072	2.142	1.930	98	50	1.699	1.873	
13	154	2.189	2.146	2.042	1899	100	2.000	1.894	
14	116	2.064	2.158	1.786	1900	92	1.964	1.870	
15	210	2.322	2.149	2.173	01	76	1.881	1.896	
16	146	2.146	2.113	2.033	02	60	1.806	1.803	
17	106	2.025	2.134	1.891	03	66	1.833	1.726	
18	102	2.007	2.101	1.908	04	34	1.531	1.639	
19	148	2.170	2.084	2.086	1903	38	1.550	1.618	
20	144	2.158	2.087	2.071	06	28	1.447	1.591	
21	114	2.057	2.104	1.953	07	50	1.699	1.614	
22	110	2.041	2.041	2.000	08	50	1.699	1.647	
23	134	2.093	2.038	2.055	09	44	1.643	1.686	
24	72	1.857	2.066	1.791	1910	56	1.748	1.686	
25	140	2.146	2.072	2.074	11	44	1.643	1.679	
26	156	2.193	2.238	1.955	13	50	1.699	1.706	
27	118	2.072	2.272	1.800	14	46	1.663	1.723	
28	84	2.024	2.443	2.501	15	60	1.778	1.750	
29	106	2.025	2.551	1.474	1914	68	1.833	1.788	
30	80	2.903	2.558	2.365	16	60	1.778	1.832	
31	68	2.833	2.282	2.551	17	74	1.892	1.838	
32	102	2.009	2.276	1.733	18	76	1.881	1.832	
33	44	1.643	2.069	1.574	19	64	1.806	1.778	
34	98	1.991	1.885	2.106	1920	64	1.806	1.773	
35	74	1.869	1.862	2.007	21	34	1.505	1.718	
36	82	1.914	1.886	2.028	22	74	1.869	1.692	
37	78	1.892	1.820	2.072	23	40	1.602	1.652	
38	58	1.763	1.815	1.948	24	48	1.681	1.987	
39	46	1.663	1.772	1.891	1925	40	1.602	1.670	
40	90	1.845	1.695	2.150	26	52	1.716	1.682	
41	50	1.699	1.692	2.007	27	46	1.748	1.652	
42	32	1.505	1.730	1.775	28	46	1.663	1.627	
43	56	1.748	1.714	2.034	29	34	1.531	1.604	
44	72	1.857	1.757	2.100	1930	30	1.477	1.514	
45	58	1.763	1.847	1.916	31	40	1.602	1.450	
46	82	1.914	1.866	2.048	32	22	1.301	1.414	
47	90	1.954	1.884	2.070	33	22	1.342	1.448	
48	70	1.845	1.930	1.915	34	24	1.350	1.340	
49	88	1.830	2.114	2.114	35	44	1.643	1.340	
50	98	1.991	1.870	2.121	36	20	1.045	1.284	
51	26	1.415	1.894	1.521	37	16	1.301	1.310	
52	144	2.158	1.894	2.264	38	16	1.064	1.270	
53	92	1.964	1.857	2.107	39	30	1.477	1.340	
54	88	1.944	1.952	1.992	1940	28	1.447	1.364	
55	64	1.806	1.912	1.894	1941	26	1.415		
56	78	1.892	1.922	1.970	1942	26			
57	90	1.954	1.840	2.114					
58	104	2.017	1.730	2.287					

TABLE 4
4,222 Year Periodic Table
Spruce Tree Rings, Johnson's Crossing
Periodic of Log from 5 Year M.A.

years after base						
Base Year	1	2	3	4	4,222	
1769				1958		
1774	1.978	2.055	2.020	1.862		
1778	2.058	1.990	2.071	1.946		
1782	1.991	1.994	2.229	1.909		
1786	2.011	1.969	1.907	2.019		
1790	2.013	2.057	1.999	2.072	1.863	
1795	2.000	2.024	1.976	2.012		
1799	2.020	2.058	1.928	2.059		
1803	1.973	2.143	2.018	1.871		
1807	1.977	2.073	2.113	1.902	1.930	
1811	2.042	1.966	2.173	2.033		
1816	1.891	1.908	2.086	2.071		
1820	1.953	2.000	2.055	1.791		
1824	2.074	1.951	1.800	2.010		
1828	1.947	2.365	2.551	2.551	1.879	
1833	2.106	2.007	2.228	2.072		
1837	1.948	1.891	2.150	2.007		
1841	1.775	2.054	2.100	1.916		
1845	2.049	2.070	1.951	2.114	2.121	
1849	1.851	2.164	2.107	1.992		
1854	1.894	1.970	2.114	2.287		
1858	1.781	1.853	2.279	2.128		
1862	1.904	1.995	1.973	1.970		
1866	2.078	2.112	1.988	1.908	2.038	
1871	1.851	2.055	2.066	2.034		
1875	2.071	1.919	1.901	1.996		
1879	2.071	2.044	1.978	2.130		
1883	1.777	1.974	2.187	1.899	1.993	
1887	2.067	2.017	1.968	2.011		
1891	2.110	1.932	1.814	2.034		
1896	2.124	1.826	2.106	2.094		
1900	1.985	2.003	2.107	1.892		
1904	1.962	1.856	2.085	2.082	1.907	
1908	2.062	1.944	1.993	1.940		
1913	2.028	2.005	1.946	2.054		
1917	2.049	2.038	2.053	1.977		
1921	2.177	1.940	1.997	1.932	2.034	
1926	2.096	2.036	1.927	1.963		
1930	2.152	1.877	1.894	2.010		
1934	2.343	1.780	1.991	1.794		
1938	2.137	2.083	2.075			
40 sections						
Σ ⁴⁴ ave	63.979 1.993	63.893 1.916	64.973 2.036	63.614 1.982		
TABLE						
Nulato, Alaska, Tree Rivers						
1799			2.045	1.978		
1803	1.944	2.017	1.991	1.997	4.200	
1807	2.057	1.990	2.045	1.995	1.973	4.078
1811	1.994	2.014	1.970	1.680		
1816	2.020	1.976	1.966	2.037		
1820	2.005	1.967	2.040	2.009		
1824	1.974	1.947	2.036	2.019		
1828	1.937	2.039	2.008	2.094	2.021	
1833	1.917	1.976	1.998	2.002		4.119
1837	2.077	1.989	2.046	1.926		
1841	1.955	1.770	2.003	1.982		
1844	2.033	2.063	2.003	1.940	2.043	
1850	1.956	1.966	2.036	2.025		
1854	2.057	1.947	2.032	1.985		
1860	1.985	2.007	1.963	2.013		
1864	1.996	1.991	2.045	1.924		
1866	2.068	1.998	2.025	2.041	1.992	
1871	1.944	2.046	2.026	1.947		
1875	2.009	2.022	2.009	1.998		
1879	1.978	1.980	2.066	1.955		
1883	2.044	1.930	1.993	2.041	1.967	
1888	1.978	2.008	2.019	2.026		
1894	2.015	1.998	1.992	1.991		
1896	2.001	2.012	1.989	1.999		
1900	1.960	2.011	2.008	1.958		
1904	2.026	2.020	1.971	2.086	1.990	
1909	2.019	2.020	1.951	1.945		
1910	1.963	1.984	2.045	2.008		
1917	2.063	1.947	1.998	2.022		
1921	1.956	2.033	2.005	2.019	2.020	
1926	1.978	1.966	2.049	1.950		
1930	1.947	2.033	2.099	1.949		
1934	2.079	1.974	1.987	1.998		
1938	1.986	1.944	1.998	2.043		
1942	1.940	2.031				
34 sections						
Σ ⁴⁴ ave	51.837 1.993	51.893 1.945	52.329 2.012	51.937 1.997		
Σ ³⁴ ave	37.832 1.991					

TABLE 5
Nulata, Alaska, Tree Rings

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149
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TABLE 6
Tree Rings, British Columbia (About 56%)
% of R "General trend of growth"

TABLE 7
Tree Rings, Fairlee, Vermont
Shrubling Loggia v. y. m. v.

4.222 Yearly growth										4.222 Yearly growth										4.222 Yearly growth										4.222 Yearly growth									
Base year	Years after Base					Base year	Years after					Base year	Years after					Base year	Years after					Base year	Years after					Base year	Years after								
1	2	3	4	4.222	1	2	3	4	4.222	1	2	3	4	4.222	1	2	3	4	4.222	1	2	3	4	4.222	1	2	3	4	4.222										
1479	116	174	130	54		1774	105	105	27	101		1546	2.123	1.962	2.070	2.131		1576	2.149	2.119	2.095	2.105		1576	2.149	2.119	2.095	2.105											
1483	112	67	48	133		1778	90	78	110	116		1550	1.689	1.689	2.082	2.112		1578	2.149	2.119	2.095	2.105		1578	2.149	2.119	2.095	2.105											
1487	112	138	148	166	121	1782	74	76	108	110		1554	1.673	2.062	2.058	1.921		1582	1.911	2.044	1.957	2.000		1582	1.911	2.044	1.957	2.000											
1491	69	90	70	93		1786	124	99	184	96		1558	2.163	2.007	1.975	2		1586	2.064	1.894	1.928	2.047		1586	2.064	1.894	1.928	2.047											
1495	69	103	84	123		1790	68	149	69	69	69	1562	2.016	2.051	1.988	1.971		1590	1.962	2.037	2.044	2.134		1590	1.962	2.037	2.044	2.134											
1499	67	103	84	89		1794	94	83	80	85		1566	2.004	2.064	1.981	2.023		1594	1.962	2.037	2.044	2.134		1594	1.962	2.037	2.044	2.134											
1444	107	107	106	112	71	1798	36	83	119	119		1570	2.053	2.053	2.053	1.984		1598	1.962	2.037	2.044	2.134		1598	1.962	2.037	2.044	2.134											
1453	56	82	98	65		1802	91	75	75	119		1574	1.987	2.057	2.076	1.984		1602	1.962	2.037	2.044	2.134		1602	1.962	2.037	2.044	2.134											
1457	60	126	119	105		1806	88	81	73	119		1578	2.057	2.057	2.057	1.984	1.604	1546	1.962	2.037	2.044	2.134		1546	1.962	2.037	2.044	2.134											
1461	54	82	116	124		1810	67	104	138	118		1582	2.094	1.987	1.987	1.984		1550	1.962	2.037	2.044	2.134		1550	1.962	2.037	2.044	2.134											
1465	54	56	83	105	110	1814	114	82	100	72		1586	2.054	1.987	1.987	1.984		1554	1.962	2.037	2.044	2.134		1554	1.962	2.037	2.044	2.134											
1470	174	74	130	140		1818	136	151	108	72		1590	1.953	2.057	1.993	1.984		1558	1.962	2.037	2.044	2.134		1558	1.962	2.037	2.044	2.134											
1474	70	66	103	99		1822	90	100	93	144		1594	2.056	2.087	1.9	2.1		1562	1.962	2.037	2.044	2.134		1562	1.962	2.037	2.044	2.134											
1478	91	98	135	152		1826	135	105	101	144		1598	1.954	2.056	2.050	2.044		1566	1.962	2.037	2.044	2.134		1566	1.962	2.037	2.044	2.134											
1482	119	100	107	142		1830	63	95	144	61		1602	1.966	1.922	2.050	2.044		1570	1.962	2.037	2.044	2.134		1570	1.962	2.037	2.044	2.134											
1486	101	189	65	150	108	1834	126	110	87	62		1606	2.001	1.901	1.901	2.044		1574	1.962	2.037	2.044	2.134		1574	1.962	2.037	2.044	2.134											
1490	70	86	64	117		1838	101	27	69	93		1610	1.966	1.969	1.969	1.969		1578	1.962	2.037	2.044	2.134		1578	1.962	2.037	2.044	2.134											
1494	103	70	89	70		1842	90	74	77	85	100	1614	1.966	1.969	1.969	2.022	1.907	1730	1.962	2.037	2.044	2.134		1730	1.962	2.037	2.044	2.134											
1498	103	50	68	102		1846	101	92	75	110		1618	1.966	1.969	1.969	2.022		1734	1.962	2.037	2.044	2.134		1734	1.962	2.037	2.044	2.134											
1502	91	104	76	98	98	1850	73	116	97	103		1622	1.966	1.969	1.969	2.022		1738	1.962	2.037	2.044	2.134		1738	1.962	2.037	2.044	2.134											
1506	86	88	66	102		1854	134	116	97	103		1626	1.966	1.969	1.969	2.022		1742	1.962	2.037	2.044	2.134		1742	1.962	2.037	2.044	2.134											
1510	118	104	125	101		1858	150	138	10	101	76	1630	1.966	1.969	1.969	2.022		1746	1.962	2.037	2.044	2.134		1746	1.962	2.037	2.044	2.134											
1514	72	98	78	103		1862	84	100	91	140		1634	2.038	1.9	1.9	2.022		1750	1.962	2.037	2.044	2.134		1750	1.962	2.037	2.044	2.134											
1518	108	88	78	107	49	1866	99	122	67	140		1638	2.038	1.9	1.9	2.022		1754	1.962	2.037	2.044	2.134		1754	1.962	2.037	2.044	2.134											
1522	62	61	100	131		1870	164	168	150	113		1642	2.038	1.9	1.9	2.022		1758	1.962	2.037	2.044	2.134		1758	1.962	2.037	2.044	2.134											
1526	59	97	101	140		1874	110	130	51	100	119	1646	2.038	1.9	1.9	2.022		1762	1.962	2.037	2.044	2.134		1762	1.962	2.037	2.044	2.134											
1530	100	120	66	96		1878	114	94	54	79		1650	2.038	1.9	1.9	2.022		1766	1.962	2.037	2.044	2.134		1766	1.962	2.037	2.044	2.134											
1534	70	66	20	44	50	1882	108	90	82	67		1654	1.997	1.990	2.038	2.066		1770	1.962	2.037	2.044	2.134		1770	1.962	2.037	2.044	2.134											
1538	103	100	101	121		1886	73	119	106	118		1658	1.997	1.990	2.038	2.066		1774	1.962	2.037	2.044	2.134		1774	1.962	2.037	2.044	2.134											
1542	95	135	68	86		1890	145	105	78	124		1662	1.997	1.990	2.038	2.066		1778	1.962	2.037	2.044	2.134		1778	1.962	2.037	2.044	2.134											
1546	53	86	68	105		1894	47	108	110	110		1666	1.997	1.990	2.038	2.066		1782	1.962	2.037	2.044	2.134		1782	1.962	2.037	2.044	2.134											
1550	77	31	91	78		1898	86	86	110	110		1670	2.032	2.055	1.964	2.064	2.093	1786	1.962	2.037	2.044	2.134		1786	1.962	2.037	2.044	2.134											
1554	73	114	85	134	82	1902	143	96	91	139		1674	1.972	1.946	2.025	2.022		1790	1.962	2.037	2.044	2.134		1790	1.962	2.037	2.044	2.134											
1558	76	114	90	104		1906	61	67	59	92		1678	2.000	1.972	1.972	2.062		1794	1.962	2.037	2.044	2.134		1794	1.962	2.037	2.044	2.134											
1562	140	131	118	107		1910	61	67	59	92		1682	2.029	1.966	2.021	2.050		1798	1.962	2.037	2.044	2.134		1798	1.962	2.037	2.044	2.134											
1566	107	118	120	107		1914	61	67	59	92		1686	1.973	1.969	2.031	1.977	2.047	1802	1.962	2.037	2.044	2.134		1802	1.962	2.037	2.044	2.134											
1570	146	90	65	62	87	1918	35	70	90	96		1690	1.990	1.972	2.033	2.045		1806	1.962	2.037	2.044	2.134		1806	1.962	2.037	2.044	2.134											
1574	166	93	138	61		1922	107	104	78	96		1694	1.991	1.946	2.081	1.990		1810	1.962	2.037	2.044	2.134		1810	1.962	2.037	2.044	2.134											
1578	106	122	100	137		1926	150	132	77	102		1698	2.036	2.104	1.972	2.155		1814	1.962	2.037	2.044	2.134		1814	1.962	2.037	2.044	2.134											
1582	98	45	100	123		1930	104	104	78	96		1702	2.115	1.919	1.973	2.154	1.990	1818	1.962	2.037	2.044	2.134		1818	1.962	2.037	2.044	2.134											
1586	171	120	134	70		1934	104	104	78	96		1706	1.954	2.114	1.991	1.985		1822	1.962	2.037	2.044	2.134		1822	1.962	2.037	2.044	2.134											
1590	130	125	117	125	83	1938	10																																

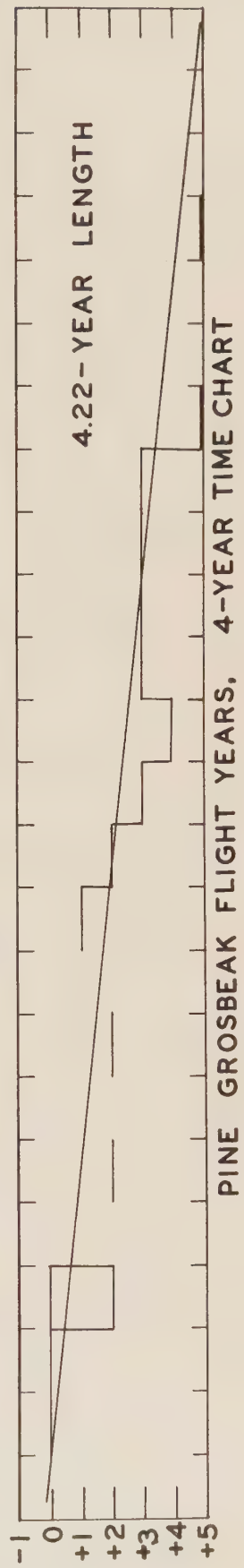
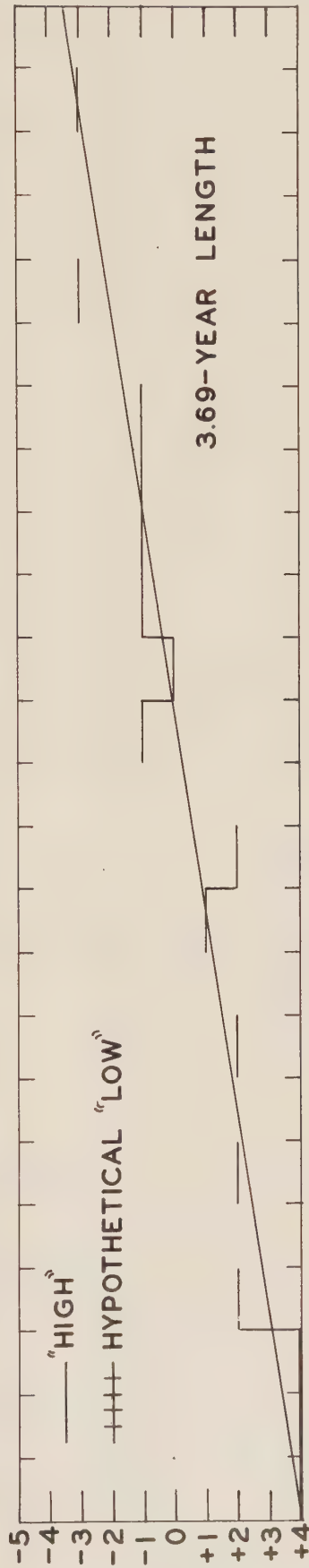
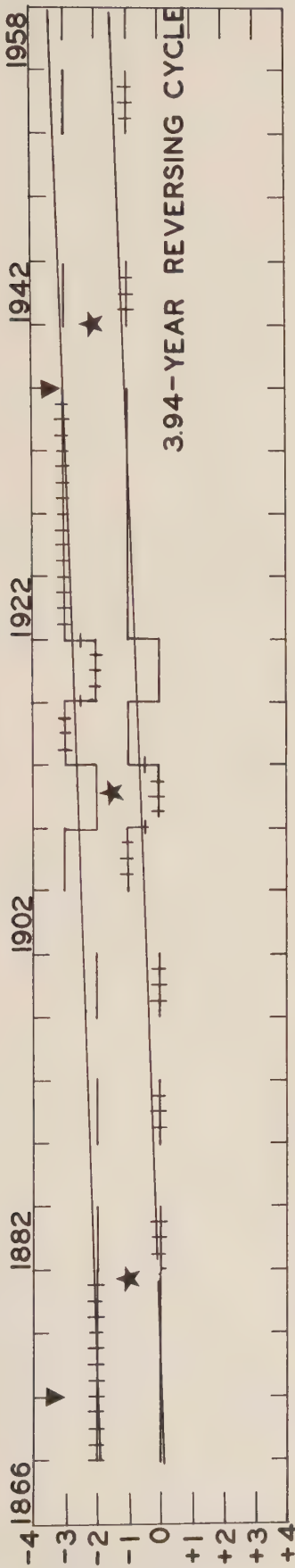
Table 8

Table 9

Table 10

Pennsylvania Tree Rings												Southwest Africa Tree Rings												
% of average growth												Deviation of Ring from Symm												
Base Year	1	2	3	4	Base Year	1	2	3	4	Base Year	1	2	3	4	Base Year	1	2	3	4	Base Year	1	2	3	4
1700	103	104	83	104	1516	2015	1049	2031	2077	1789	1953	2005	1987	1998	2009	1676	2.236	1.741	1.794	2.179	2408			
1706	136	111	120	92	1520	2008	1913	1937	2003	1794	1983	2006	1997	1919	2009	1681	2.077	1.778	1.650	2.129				
1710	90	102	111	104	1524	2014	1993	2006	1990	1798	2008	2008	1999	1913	2009	1685	2.156	1.971	1.940	2.228				
1714	100	100	114	131	1528	2016	2008	2006	1976	1802	1985	2005	1996	1916	2009	1689	1.837	1.804	1.861	2.219	2.251			
1719	106	98	130	87	1533	2018	1991	2004	2004	1806	1987	2009	1997	1917	2009	1693	2.249	1.473	1.965	1.833				
1723	95	95	115	107	1537	1977	1991	2032	1957	1810	2006	2001	1997	1917	2009	1697	2.209	2.340	1.856	1.710				
1727	101	77	88	106	1541	2002	2005	1904	1955	1814	1910	2006	1992	1917	2009	1702	1.787	2.183	2.007	2.065				
1731	101	86	87	100	1545	2006	1999	1987	2008	1818	1987	2006	1993	1917	2009	1706	2.093	1.904	1.988	2.074				
1736	93	75	88	82	1549	1998	2008	2050	2008	1822	1986	1938	1997	1918	2009	1710	2.134	1.528	1.869	2.282	2.305			
1740	102	78	93	98	1553	1998	2001	2168	2006	1826	1986	1938	1997	1918	2009	1714	2.065	1.801	1.761	1.992				
1745	99	103	85	96	1557	1998	1998	2032	1793	1830	1986	1938	1997	1918	2009	1718	2.170	1.967	2.005	2.047				
1749	87	87	95	91	1561	2003	1982	2022	1793	1834	1986	1938	1997	1918	2009	1722	2.048	2.148	1.765	2.054				
1753	90	88	101	88	1565	1987	2002	2022	1793	1838	1986	1938	1997	1918	2009	1726	2.170	1.967	2.005	2.047				
1757	107	97	125	110	1569	1987	2002	2022	1793	1842	1986	1938	1997	1918	2009	1730	2.045	1.801	1.761	2.047				
1761	106	106	103	113	1573	2007	2004	1986	2008	1846	1986	1938	1997	1918	2009	1734	2.185	2.075	1.915	1.662	2.020			
1765	99	88	98	91	1577	2007	2004	1986	2008	1850	1986	1938	1997	1918	2009	1738	2.263	2.016	2.117	1.827				
1769	107	74	84	76	1581	2007	2004	1986	2008	1854	1986	1938	1997	1918	2009	1742	2.013	1.879	1.997	1.850				
1773	97	103	100	101	1585	2007	2004	1986	2008	1858	1986	1938	1997	1918	2009	1746	2.074	2.121	2.057	1.712				
1777	114	97	97	91	1589	2007	2004	1986	2008	1862	1986	1938	1997	1918	2009	1750	2.127	1.823	1.937	1.707				
1781	103	84	84	81	1593	1987	1988	1974	2009	1866	1986	1938	1997	1918	2009	1754	2.155	2.022	1.976	2.001	1.864			
1785	119	121	121	114	1597	1987	1988	1974	2009	1870	1986	1938	1997	1918	2009	1758	1.726	2.295	2.048	1.754				
1789	91	100	87	97	1601	1987	1988	1974	2009	1874	1986	1938	1997	1918	2009	1762	1.893	2.128	2.126	1.869				
1793	86	84	109	102	1605	1987	1988	1974	2009	1878	1986	1938	1997	1918	2009	1766	1.949	1.990	2.105	1.998				
1797	92	99	97	104	1609	1987	1988	1974	2009	1882	1986	1938	1997	1918	2009	1770	2.220	2.177	2.135	1.715	2.013			
1801	105	90	105	94	1613	1987	1988	1974	2009	1886	1986	1938	1997	1918	2009	1774	2.199	1.986	1.751	1.751				
1805	94	111	90	95	1617	1987	1988	1974	2009	1890	1986	1938	1997	1918	2009	1778	2.223	1.996	2.054	1.780				
1809	107	127	120	137	1621	1987	1988	1974	2009	1894	1986	1938	1997	1918	2009	1782	1.941	2.102	2.134	2.074				
1813	116	127	120	137	1625	2007	2004	1986	2008	1898	1986	1938	1997	1918	2009	1786	1.856	1.896	1.999	1.848				
1817	107	111	111	122	1629	2007	2004	1986	2008	1902	1986	1938	1997	1918	2009	1790	2.091	2.119	2.094	1.707	2.301			
1821	64	86	94	103	1633	2007	2004	1986	2008	1906	1986	1938	1997	1918	2009	1794	2.055	2.236	2.113	2.417				
1825	118	132	117	122	1637	2007	2004	1986	2008	1910	1986	1938	1997	1918	2009	1798	1.870	2.117	2.046	1.787				
1829	124	132	133	126	1641	2007	2004	1986	2008	1914	1986	1938	1997	1918	2009	1802	1.926	2.139	2.046	1.521	1.805			
1833	114	130	125	114	1645	2007	2004	1986	2008	1918	1986	1938	1997	1918	2009	1806	2.124	2.238	1.780	2.000				
1837	112	131	64	83	1649	2007	2004	1986	2008	1922	1986	1938	1997	1918	2009	1810	1.981	1.899	2.002	2.055				
1841	85	107	107	89	1653	2007	2004	1986	2008	1926	1986	1938	1997	1918	2009	1814	2.020	1.603	2.125	2.187				
1845	109	123	113	112	1657	2007	2004	1986	2008	1930	1986	1938	1997	1918	2009	1818	1.956	1.899	2.152	2.088				
1849	121	129	113	90	1661	2007	2004	1986	2008	1934	1986	1938	1997	1918	2009	1822	2.054	1.603	2.125	2.055				
1853	97	80	89	96	1665	2007	2004	1986	2008	1938	1986	1938	1997	1918	2009	1826	1.872	1.943	2.146	1.719	2.074			
1857	92	123	104	107	1669	2007	2004	1986	2008	1942	1986	1938	1997	1918	2009	1830	2.066	1.899	2.152	2.088				
1861	99	99	97	97	1673	2007	2004	1986	2008	1946	1986	1938	1997	1918	2009	1834	1.871	1.943	2.146	1.719				
1865	110	100	97	77	1677	2007	2004	1986	2008	1950	1986	1938	1997	1918	2009	1838	2.085	1.864	1.947	2.014				
1869	94	87	81	88	1681	2007	2004	1986	2008	1954	1986	1938	1997	1918	2009	1842	1.944	2.074	1.915	1.747				
1873	110	110	97	77	1685	2007	2004	1986	2008	1958	1986	1938	1997	1918	2009	1846	2.066	2.059	2.087	1.754				
1877	94	87	81	88	1689	2007	2004	1986	2008	1962	1986	1938	1997	1918	2009	1850	2.049	1.850	1.943	2.066	2.011			
1881	87	112	79	108	1693	2007	2004	1986	2008	1966	1986	1938	1997	1918	2009	1854	1.977	2.155	2.004	1.715				
1885	79	93	83	108	1697	2007	2004	1986	2008	1970	1986	1938	1997	1918	2009	1858	1.850	1.877	2.183	2.099	1.758			
1889	116	128	81	92	1701	2007	2004	1986	2008	1974	1986	1938	1997	1918	2009	1862	1.927	1.966	1.967	2.139				
1893	71	108	102	74	1705	2007	2004	1986	2008	1978	1986	1938	1997	1918	2009	1866	2.085	1.864	1.947	2.014				
1897	73	83	93	95	1709	2007	2004	1986	2008	1982	1986	1938	1997	1918	2009	1870	1.977	2.074	1.915	1.747				
1901	69	102	116	97	1713	2007	2004	1986	2008	1986	1986	1938	1997	1918	2009	1874	2.085	1.864	1.947	2.014				
1905	95	94	102	121	1717	2007	2004	1986	2008	1990	1986	1938	1997	1918	2009	1878	1.944	2.074	1.915	1.747				
1909	95	117	97	92	1721	2007	2004	1986	2008	1994	1986	1938	1997	1918	2009	1882	2.066	2.059	2.087	1.754				
1913	105	82	99	120	1725	2007	2004	1986	2008	1998	1986	1938	1997	1918	2009	1886	2.049	1.850	1.943	2.066				
1917	95	89	90	79	1729	2007	2004	1986	2008	2002	1986	1938	1997	1918	2009	1890	1.977	2.155	2					

FIGURE 1



PINE GROSBEAK FLIGHT YEARS, 4-YEAR TIME CHART

Figure 2

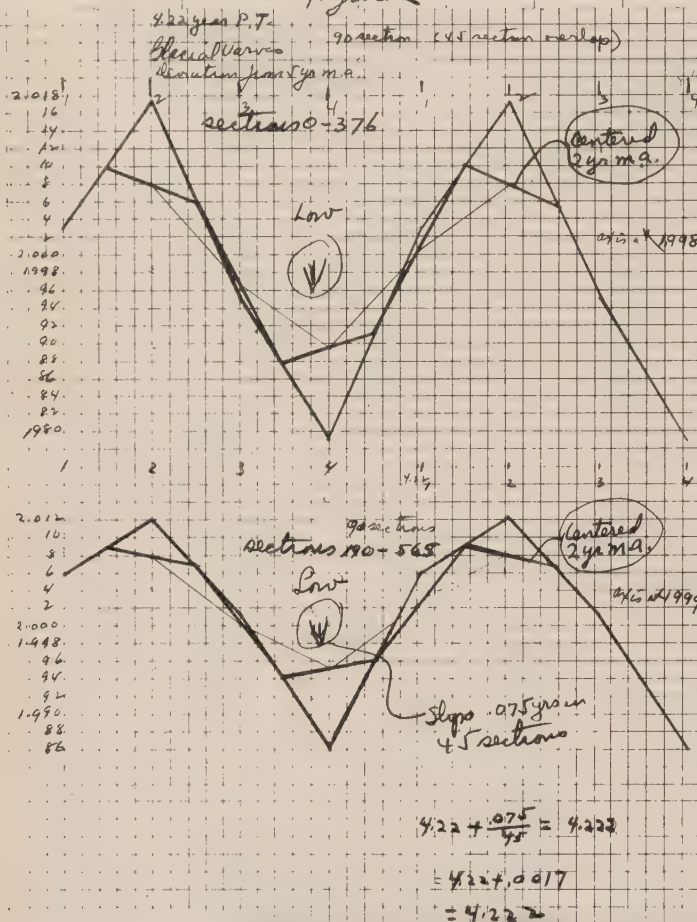


Figure 3

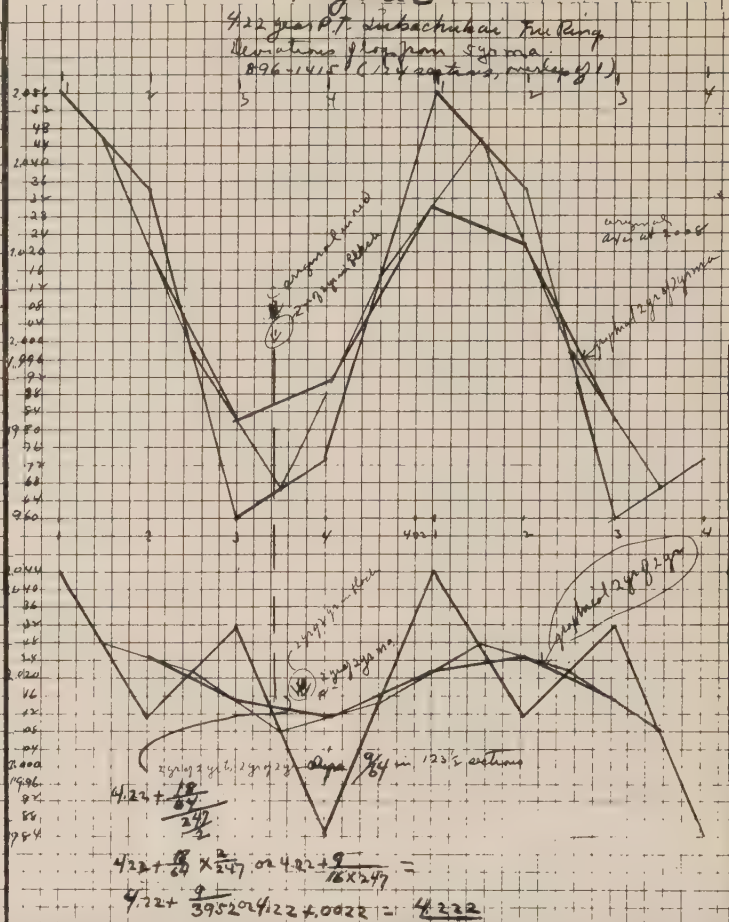


Figure 4

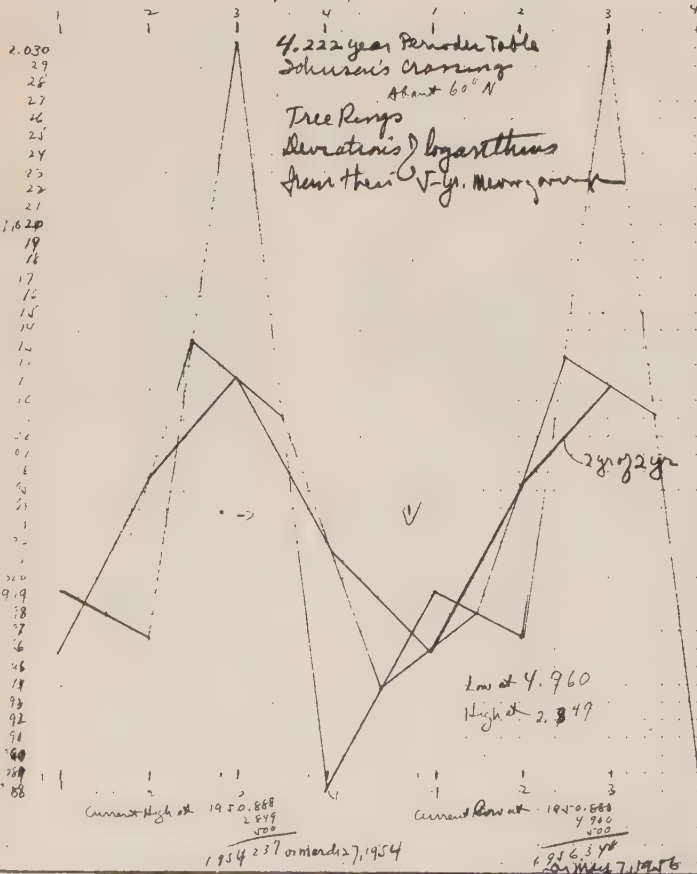


Figure 5

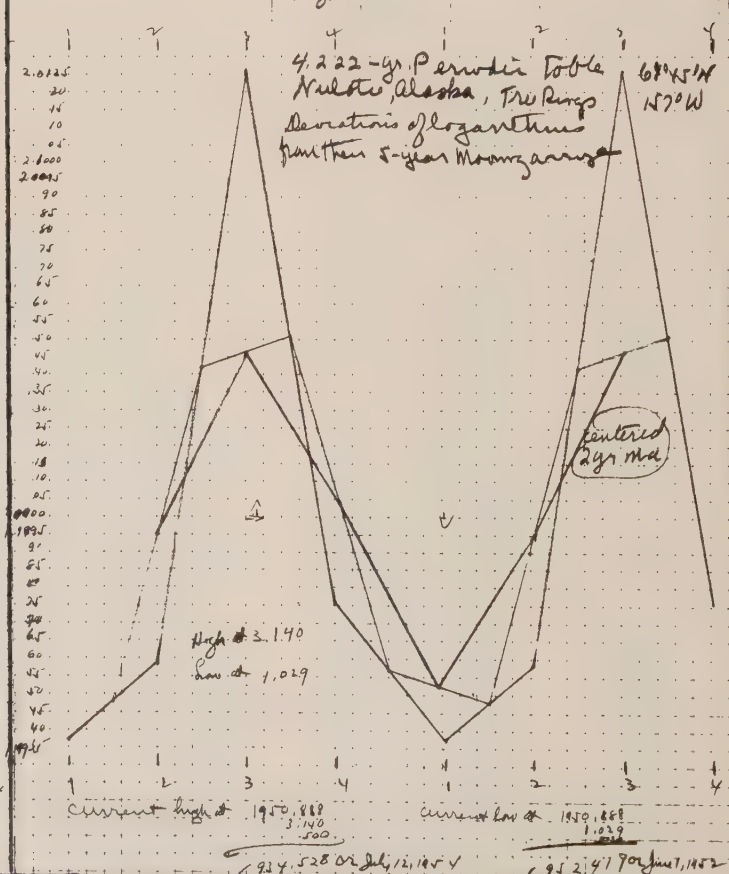


Figure 6
4222 year Periodic Table, Tree Rings
British Columbia, % of "Generalized growth"

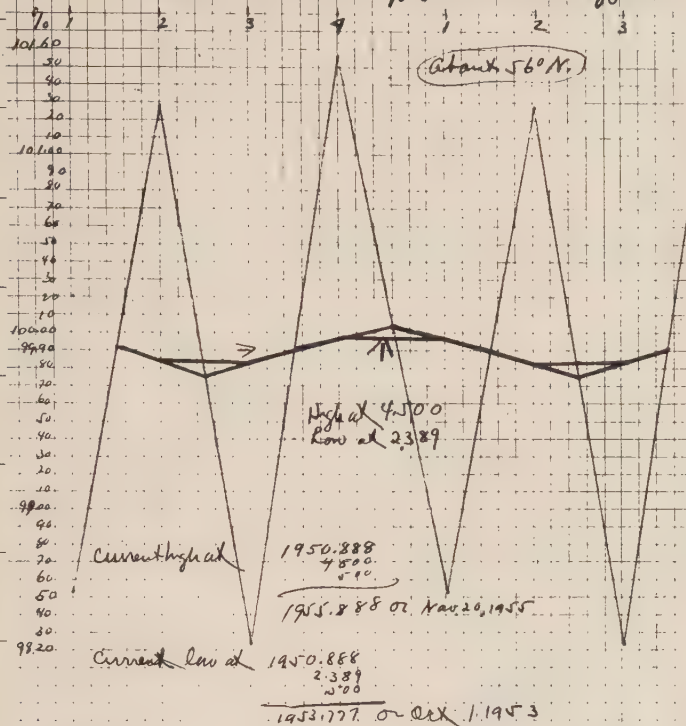


Figure 7
4222 year PT.
Tree Rings, Fairlie, N. Carolina
Whole table 1946-1926 (91 sections)

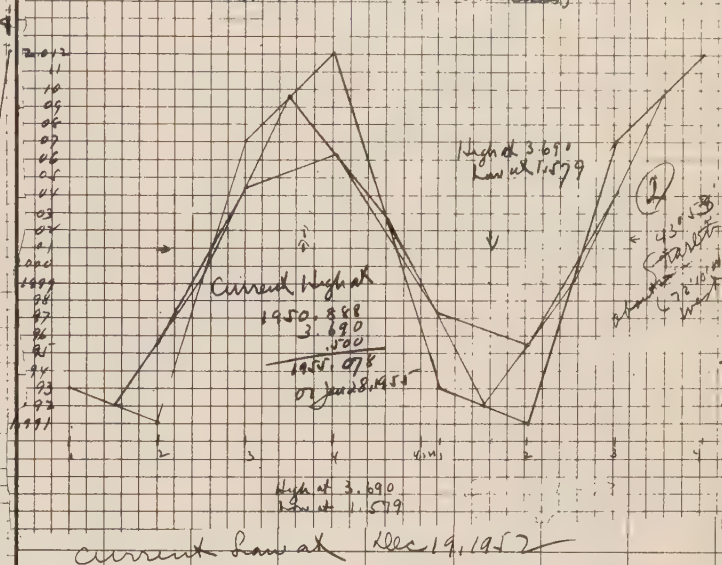


Figure 8
4222 year PT.
Shaded Pine Tree Rings
% deviation from average growth

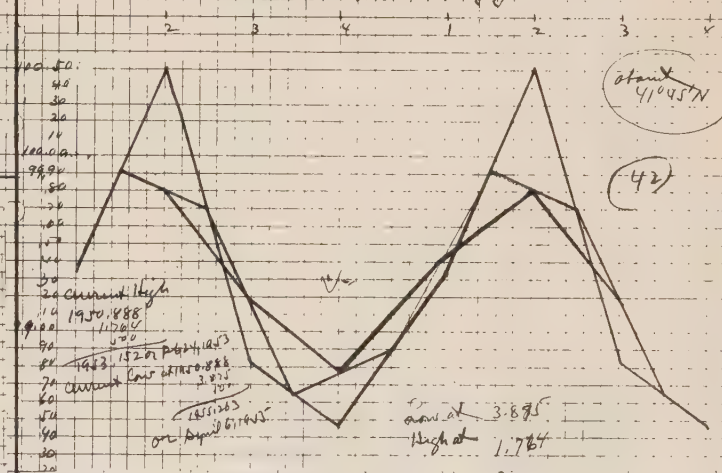


Figure 9
4222 year PT.
Java Tree Rings (*Tectona grandis*)
Deviation of log pinnis yma

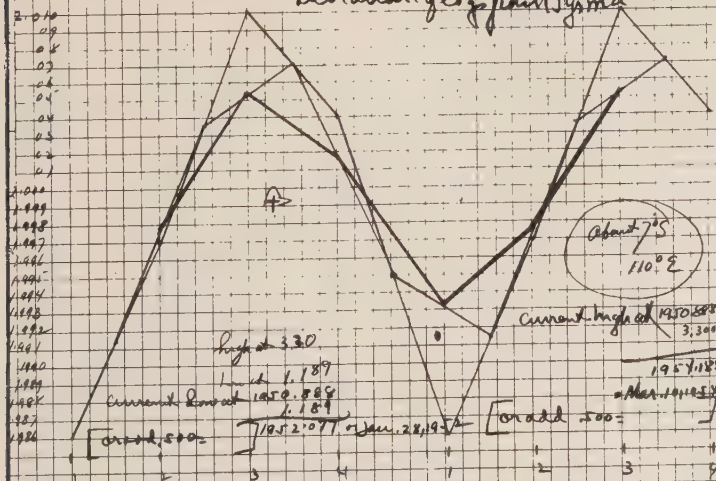
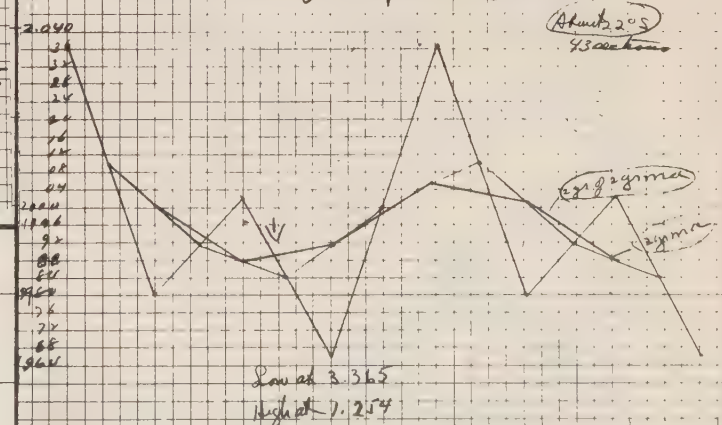
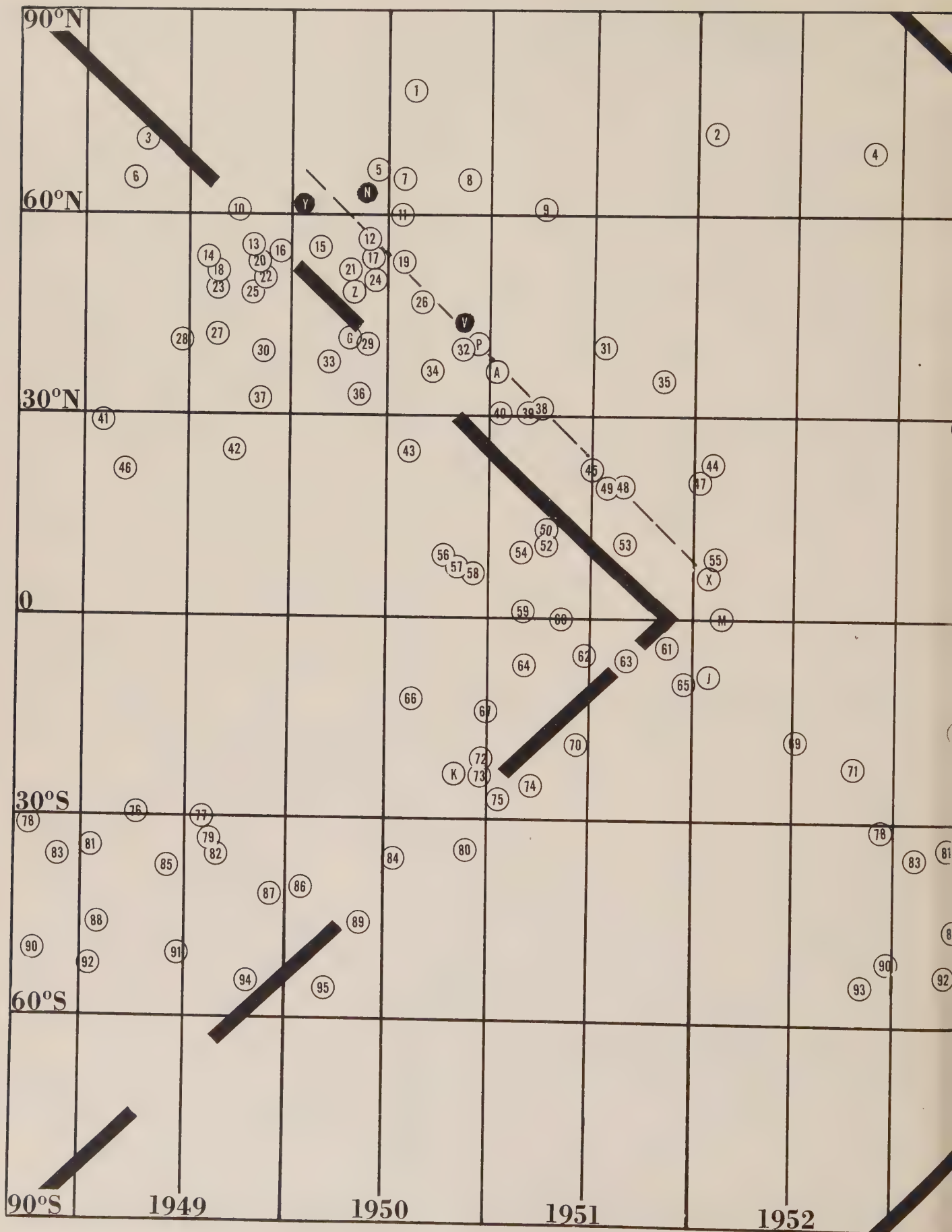
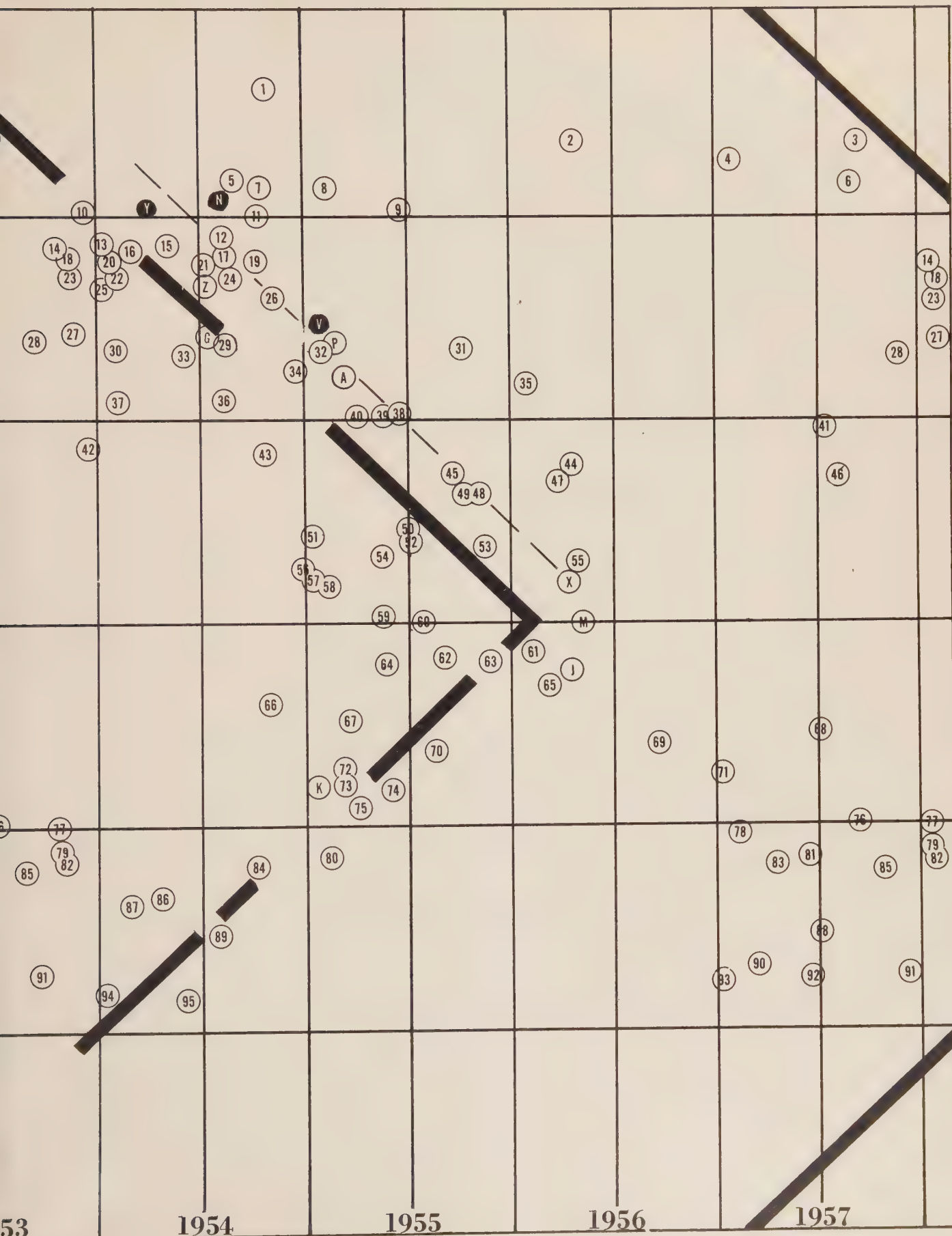


Figure 10
4222 year PT.
Savannah Africa Tree Rings
Deviation of log pinnis yma





RE II



4.222-year Periodic Table

Deviations of logarithms from their 5-year moving average

Locations of Logskidder from this 5-Year Moving Average

Years after base					Years after base					Years after base					Years after base				
Base year	1	2	3	4	Base year	1	2	3	4	Base year	1	2	3	4	Base year	1	2	3	4
1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949
1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069
2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089
2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	2101	2102	2103	2104	2105	2106	2107	2108	2109
2110	2111	2112	2113	2114	2115	2116	2117	2118	2119	2120	2121	2122	2123	2124	2125	2126	2127	2128	2129
2130	2131	2132	2133	2134	2135	2136	2137	2138	2139	2140	2141	2142	2143	2144	2145	2146	2147	2148	2149
2150	2151	2152	2153	2154	2155	2156	2157	2158	2159	2160	2161	2162	2163	2164	2165	2166	2167	2168	2169
2170	2171	2172	2173	2174	2175	2176	2177	2178	2179	2180	2181	2182	2183	2184	2185	2186	2187	2188	2189
2190	2191	2192	2193	2194	2195	2196	2197	2198	2199	2200	2201	2202	2203	2204	2205	2206	2207	2208	2209
2210	2211	2212	2213	2214	2215	2216	2217	2218	2219	2220	2221	2222	2223	2224	2225	2226	2227	2228	2229
2230	2231	2232	2233	2234	2235	2236	2237	2238	2239	2240	2241	2242	2243	2244	2245	2246	2247	2248	2249
2250	2251	2252	2253	2254	2255	2256	2257	2258	2259	2260	2261	2262	2263	2264	2265	2266	2267	2268	2269
2270	2271	2272	2273	2274	2275	2276	2277	2278	2279	2280	2281	2282	2283	2284	2285	2286	2287	2288	2289
2290	2291	2292	2293	2294	2295	2296	2297	2298	2299	2300	2301	2302	2303	2304	2305	2306	2307	2308	2309
2310	2311	2312	2313	2314	2315	2316	2317	2318	2319	2320	2321	2322	2323	2324	2325	2326	2327	2328	2329
2330	2331	2332	2333	2334	2335	2336	2337	2338	2339	2340	2341	2342	2343	2344	2345	2346	2347	2348	2349
2350	2351	2352	2353	2354	2355	2356	2357	2358	2359	2360	2361	2362	2363	2364	2365	2366	2367	2368	2369
2370	2371	2372	2373	2374	2375	2376	2377	2378	2379	2380	2381	2382	2383	2384	2385	2386	2387	2388	2389
2390	2391	2392	2393	2394	2395	2396	2397	2398	2399	2400	2401	2402	2403	2404	2405	2406	2407	2408	2409
2410	2411	2412	2413	2414	2415	2416	2417	2418	2419	2420	2421	2422	2423	2424	2425	2426	2427	2428	2429
2430	2431	2432	2433	2434	2435	2436	2437	2438	2439	2440	2441	2442	2443	2444	2445	2446	2447	2448	2449
2450	2451	2452	2453	2454	2455	2456	2457	2458	2459	2460	2461	2462	2463	2464	2465	2466	2467	2468	2469
2470	2471	2472	2473	2474	2475	2476	2477	2478	2479	2480	2481	2482	2483	2484	2485	2486	2487	2488	2489
2490	2491	2492	2493	2494	2495	2496	2497	2498	2499	2500	2501	2502	2503	2504	2505	2506	2507	2508	2509
2510	2511	2512	2513	2514	2515	2516	2517	2518	2519	2520	2521	2522	2523	2524	2525	2526	2527	2528	2529
2530	2531	2532	2533	2534	2535	2536	2537	2538	2539	2540	2541	2542	2543	2544	2545	2546	2547	2548	2549
2550	2551	2552	2553	2554	2555	2556	2557	2558	2559	2560	2561	2562	2563	2564	2565	2566	2567	2568	2569
2570	2571	2572	2573	2574	2575	2576	2577	2578	2579	2580	2581	2582	2583	2584	2585	2586	2587	2588	2589
2590	2591	2592	2593	2594	2595	2596	2597	2598	2599	2600	2601	2602	2603	2604	2605	2606	2607	2608	2609
2610	2611	2612	2613	2614	2615	2616	2617	2618	2619	2620	2621	2622	2623	2624	2625	2626	2627	2628	2629
2630	2631	2632	2633	2634	2635	2636	2637	2638	2639	2640	2641	2642	2643	2644	2645	2646	2647	2648	2649
2650	2651	2652	2653	2654	2655	2656	2657	2658	2659	2660	2661	2662	2663	2664	2665	2666	2667	2668	2669
2670	2671	2672	2673	2674	2675	2676	2677	2678	2679	2680	2681	2682	2683	2684	2685	2686	2687	2688	2689
2690	2691	2692	2693	2694	2695	2696	2697	2698	2699	2700	2701	2702	2703	2704	2705	2706	2707	2708	2709
2710	2711	2712	2713	2714	2715	2716	2717	2718	2719	2720	2721	2722	2723	2724	2725	2726	2727	2728	2729
2730	2731	2732	2733	2734	2735	2736	2737	2738	2739	2740	2741	2742	2743	2744	2745	2746	2747	2748	2749
2750	2751	2752	2753	2754	2755	2756	2757	2758	2759	2760	2761	2762	2763	2764	2765	2766	2767	2768	2769
2770	2771	2772	2773	2774	2775	2776	2777	2778	2779	2780	2781	2782	2783	2784	2785	2786	2787	2788	2789
2790	2791	2792	2793	2794	2795	2796	2797	2798	2799	2800	2801	2802	2803	2804	2805	2806	2807	2808	2809
2810	2811	2812	2813	2814	2815	2816	2817	2818	2819	2820	2821	2822	2823	2824	2825	2826	2827	2828	2829
2830	2831	2832	2833	2834	2835	2836	2837	2838	2839	2840	2841	2842	2843	2844	2845	2846	2847	2848	2849
2850	2851	2852	2853	2854	2855	2856	2857	2858	2859	2860	2861	2862	2863	2864	2865	2866	2867	2868	2869
2870	2871	2872	2873	2874	2875	2876	2877	2878	2879	2880	2881	2882	2883	2884	2885	2886	2887	2888	2889
2890	2891	2892	2893	2894	2895	2896	2897	2898	2899	2900	2901	2902	2903	2904	2905	2906	2907	2908	2909
2910	2911	2912	2913	2914	2915	2916	2917	2918	2919	2920	2921	2922	2923	2924	2925	2926	2927	2928	2929
2930	2931	2932	2933	2934	2935	2936	2937	2938	2939	2940	2941	2942	2943	2944	2945	2946	2947	2948	2949
2950	2951	2952	2953	2954	2955	2956	2957	2958	2959	2960	2961	2962	2963	2964	2965	2966	2967	2968	2969
2970	2971	2972	2973	2974	2975	2976	2977	2978	2979	2980	2981	2982	2983	2984	2985	2986	2987	2988	2989
2990	2991	2992	2993	2994	2995	2996	2997	2998	2999	3000	3001	3002	3003	3004	3005	3006	3007	3008	3009
3010	3011	3012	3013	3014	3015	3016	3017	3018	3019	3020	3021	3022	3023	3024	3025	3026	3027	3028	3029
3030	3031	3032	3033	3034	3035	3036	3037	3038	3039	3040	3041	3042	3043	3044	3045	3046	3047	3048	3049
3050	3051	3052	3053	3054	3055	3056	3057	3058	3059	3060	3061	3062	3063	3064	3065	3066	3067	3068	3069
3070	3071	3072	3073	3074	3075	3076	3077	3078	3079	3080	3081	3082	3083	3084	3085	3086	3087	3088	3089
3090	3091	3092	3093	3094	3095	3096	3097	3098	3099	3100	3101	3102	3103	3104	3105	3106	3107	3108	3109
3110	3111	3112	3113	3114	3115	3116	3117	3118	3119	3120	3121	3122	3123	3124	3125	3126	3127	3128	3129
3130	3131	3132	3133	3134	3135	3136	3137	3138	3139	3140	3141	3142	3143	3144	3145	3146	3147	3148	3149
3150	3151	3152	3153	3154	3155	3156	3157	3158	3159	3160	3161	3162	3163	3164	3165	3166	3167	3168	3169
3170	3171	3172	3173	3174	3175	3176	3177	3178	3179	3180	3181	3182	3183	3184	3185	3186	3187	3188	3189
3190	3191	3192	3193	3194	3195	3196	3197	3198	3199	3200	3201	3202	3203	3204	3205	3206	3207	3208	3209
3210	3211	3212	3213	3214	3215	3216	3												

Years after base						Years after base						Years after base						Years after base					
Base year	1	2	3	4	4.222	Base year	1	2	3	4	4.222	Base year	1	2	3	4	4.222	Base year	1	2	3	4	4.222
33 Chongming, U.S.A.																							
1875	1990	1990	1990	1990		1882	1990	1990	1990	1990		1890	1990	1990	1990	1990		1898	1990	1990	1990	1990	
1876	1991	1991	1991	1991		1883	1991	1991	1991	1991		1891	1991	1991	1991	1991		1899	1991	1991	1991	1991	
1877	1992	1992	1992	1992		1884	1992	1992	1992	1992		1892	1992	1992	1992	1992		1900	1992	1992	1992	1992	
1878	1993	1993	1993	1993		1885	1993	1993	1993	1993		1893	1993	1993	1993	1993		1901	1993	1993	1993	1993	
1879	1994	1994	1994	1994		1886	1994	1994	1994	1994		1894	1994	1994	1994	1994		1902	1994	1994	1994	1994	
1880	1995	1995	1995	1995		1887	1995	1995	1995	1995		1895	1995	1995	1995	1995		1903	1995	1995	1995	1995	
1881	1996	1996	1996	1996		1888	1996	1996	1996	1996		1896	1996	1996	1996	1996		1904	1996	1996	1996	1996	
1882	1997	1997	1997	1997		1889	1997	1997	1997	1997		1897	1997	1997	1997	1997		1905	1997	1997	1997	1997	
1883	1998	1998	1998	1998		1890	1998	1998	1998	1998		1898	1998	1998	1998	1998		1906	1998	1998	1998	1998	
1884	1999	1999	1999	1999		1891	1999	1999	1999	1999		1899	1999	1999	1999	1999		1907	1999	1999	1999	1999	
1885	2000	2000	2000	2000		1892	2000	2000	2000	2000		1900	2000	2000	2000	2000		1908	2000	2000	2000	2000	
1886	2001	2001	2001	2001		1893	2001	2001	2001	2001		1901	2001	2001	2001	2001		1909	2001	2001	2001	2001	
1887	2002	2002	2002	2002		1894	2002	2002	2002	2002		1902	2002	2002	2002	2002		1910	2002	2002	2002	2002	
1888	2003	2003	2003	2003		1895	2003	2003	2003	2003		1903	2003	2003	2003	2003		1911	2003	2003	2003	2003	
1889	2004	2004	2004	2004		1896	2004	2004	2004	2004		1904	2004	2004	2004	2004		1912	2004	2004	2004	2004	
1890	2005	2005	2005	2005		1897	2005	2005	2005	2005		1905	2005	2005	2005	2005		1913	2005	2005	2005	2005	
1891	2006	2006	2006	2006		1898	2006	2006	2006	2006		1906	2006	2006	2006	2006		1914	2006	2006	2006	2006	
1892	2007	2007	2007	2007		1899	2007	2007	2007	2007		1907	2007	2007	2007	2007		1915	2007	2007	2007	2007	
1893	2008	2008	2008	2008		1900	2008	2008	2008	2008		1908	2008	2008	2008	2008		1916	2008	2008	2008	2008	
1894	2009	2009	2009	2009		1901	2009	2009	2009	2009		1909	2009	2009	2009	2009		1917	2009	2009	2009	2009	
1895	2010	2010	2010	2010		1902	2010	2010	2010	2010		1910	2010	2010	2010	2010		1918	2010	2010	2010	2010	
1896	2011	2011	2011	2011		1903	2011	2011	2011	2011		1911	2011	2011	2011	2011		1919	2011	2011	2011	2011	
1897	2012	2012	2012	2012		1904	2012	2012	2012	2012		1912	2012	2012	2012	2012		1920	2012	2012	2012	2012	
1898	2013	2013	2013	2013		1905	2013	2013	2013	2013		1913	2013	2013	2013	2013		1921	2013	2013	2013	2013	
1899	2014	2014	2014	2014		1906	2014	2014	2014	2014		1914	2014	2014	2014	2014		1922	2014	2014	2014	2014	
1900	2015	2015	2015	2015		1907	2015	2015	2015	2015		1915	2015	2015	2015	2015		1923	2015	2015	2015	2015	
1901	2016	2016	2016	2016		1908	2016	2016	2016	2016		1916	2016	2016	2016	2016		1924	2016	2016	2016	2016	
1902	2017	2017	2017	2017		1909	2017	2017	2017	2017		1917	2017	2017	2017	2017		1925	2017	2017	2017	2017	
1903	2018	2018	2018	2018		1910	2018	2018	2018	2018		1918	2018	2018	2018	2018		1926	2018	2018	2018	2018	
1904	2019	2019	2019	2019		1911	2019	2019	2019	2019		1919	2019	2019	2019	2019		1927	2019	2019	2019	2019	
1905	2020	2020	2020	2020		1912	2020	2020	2020	2020		1920	2020	2020	2020	2020		1928	2020	2020	2020	2020	
1906	2021	2021	2021	2021		1913	2021	2021	2021	2021		1921	2021	2021	2021	2021		1929	2021	2021	2021	2021	
1907	2022	2022	2022	2022		1914	2022	2022	2022	2022		1922	2022	2022	2022	2022		1930	2022	2022	2022	2022	
1908	2023	2023	2023	2023		1915	2023	2023	2023	2023		1923	2023	2023	2023	2023		1931	2023	2023	2023	2023	
1909	2024	2024	2024	2024		1916	2024	2024	2024	2024		1924	2024	2024	2024	2024		1932	2024	2024	2024	2024	
1910	2025	2025	2025	2025		1917	2025	2025	2025	2025		1925	2025	2025	2025	2025		1933	2025	2025	2025	2025	
1911	2026	2026	2026	2026		1918	2026	2026	2026	2026		1926	2026	2026	2026	2026		1934	2026	2026	2026	2026	
1912	2027	2027	2027	2027		1919	2027	2027	2027	2027		1927	2027	2027	2027	2027		1935	2027	2027	2027	2027	
1913	2028	2028	2028	2028		1920	2028	2028	2028	2028		1928	2028	2028	2028	2028		1936	2028	2028	2028	2028	
1914	2029	2029	2029	2029		1921	2029	2029	2029	2029		1929	2029	2029	2029	2029		1937	2029	2029	2029	2029	
1915	2030	2030	2030	2030		1922	2030	2030	2030	2030		1930	2030	2030	2030	2030		1938	2030	2030	2030	2030	
1916	2031	2031	2031	2031		1923	2031	2031	2031	2031		1931	2031	2031	2031	2031		1939	2031	2031	2031	2031	
1917	2032	2032	2032	2032		1924	2032	2032	2032	2032		1932	2032	2032	2032	2032		1940	2032	2032	2032	2032	
1918	2033	2033	2033	2033		1925	2033	2033	2033	2033		1933	2033	2033	2033	2033		1941	2033	2033	2033	2033	
1919	2034	2034	2034	2034		1926	2034	2034	2034	2034		1934	2034	2034	2034	2034		1942	2034	2034	2034	2034	
1920	2035	2035	2035	2035		1927	2035	2035	2035	2035		1935	2035	2035	2035	2035		1943	2035	2035	2035	2035	
1921	2036	2036	2036	2036		1928	2036	2036	2036	2036		1936	2036	2036	2036	2036		1944	2036	2036	2036	2036	
1922	2037	2037	2037	2037		1929	2037	2037	2037	2037		1937	2037	2037	2037	2037		1945	2037	2037	2037	2037	
1923	2038	2038	2038	2038		1930	2038	2038	2038	2038		1938	2038	2038	2038	2038		1946	2038	2038	2038	2038	
1924	2039	2039	2039	2039		1931	2039	2039	2039	2039		1939	2039	2039	2039	2039		1947	2039	2039	2039	2039	
1925	2040	2040	2040	2040		1932	2040	2040	2040	2040		1940	2040	2040	2040	2040		1948	2040	2040	204		

Base Year	Years after base					Base Year	Years after base					Base Year	Years after base					Base Year	Years after base				
	1	2	3	4	4.222		1	2	3	4	4.222		1	2	3	4	4.222		1	2	3	4	4.222
(46) Honolulu, Hawaii																							
1983	1.9985	1.9985	2.0001	1.9980	2.0009	Σ	30.0015	30.0169	30.0082	29.9810	Σ	1983	1.9985	1.9985	2.0001	1.9980	2.0009	Σ	30.0015	30.0169	30.0082	29.9810	
1984	2.0003	1.9993	2.0001	2.0024		1984	2.0003	1.9993	2.0001	2.0024	1984	2.0003	1.9993	2.0001	2.0024		1984	2.0003	1.9993	2.0001	2.0024		
1985	1.9999	1.9957	1.9997	2.0027		1985	1.9999	1.9957	1.9997	2.0027	1985	1.9999	1.9957	1.9997	2.0027		1985	1.9999	1.9957	1.9997	2.0027		
1986	2.0028	1.9960	1.9999	2.0041		1986	2.0028	1.9960	1.9999	2.0041	1986	2.0028	1.9960	1.9999	2.0041		1986	2.0028	1.9960	1.9999	2.0041		
1987	2.0017	1.9978	1.9973	2.0031		1987	2.0017	1.9978	1.9973	2.0031	1987	2.0017	1.9978	1.9973	2.0031		1987	2.0017	1.9978	1.9973	2.0031		
1988	1.9944	2.0019	2.0009	2.0009	1.9971	1988	1.9944	2.0019	2.0009	2.0009	1.9971	1988	1.9944	2.0019	2.0009	2.0009	1.9971	1988	1.9944	2.0019	2.0009	2.0009	1.9971
1989	1.9976	1.9990	2.0004	2.0021		1989	1.9976	1.9990	2.0004	2.0021	1989	1.9976	1.9990	2.0004	2.0021		1989	1.9976	1.9990	2.0004	2.0021		
1990	1.9989	2.0016	1.9983	2.0001		1990	1.9989	2.0016	1.9983	2.0001	1990	1.9989	2.0016	1.9983	2.0001		1990	1.9989	2.0016	1.9983	2.0001		
1991	1.9986	2.0007	2.0004	2.0000		1991	1.9986	2.0007	2.0004	2.0000	1991	1.9986	2.0007	2.0004	2.0000		1991	1.9986	2.0007	2.0004	2.0000		
1992	1.9987	2.0001	1.9978	2.0000	2.0007	1992	1.9987	2.0001	1.9978	2.0000	2.0007	1992	1.9987	2.0001	1.9978	2.0000	2.0007	1992	1.9987	2.0001	1.9978	2.0000	2.0007
1993	2.0007	1.9984	2.0002	2.0003		1993	2.0007	1.9984	2.0002	2.0003		1993	2.0007	1.9984	2.0002	2.0003		1993	2.0007	1.9984	2.0002	2.0003	
1994	2.0011	1.9991	1.9989	2.0003		1994	2.0011	1.9991	1.9989	2.0003		1994	2.0011	1.9991	1.9989	2.0003		1994	2.0011	1.9991	1.9989	2.0003	
1995	2.0020	1.9999	1.9983	2.0017		1995	2.0020	1.9999	1.9983	2.0017		1995	2.0020	1.9999	1.9983	2.0017		1995	2.0020	1.9999	1.9983	2.0017	
Σ	1.9993	1.9946	1.9806	1.9819		Σ	1.9993	1.9946	1.9806	1.9819		Σ	1.9993	1.9946	1.9806	1.9819		Σ	1.9993	1.9946	1.9806	1.9819	
ave	1.9999	1.9990	2.0000	2.0014		ave	1.9999	1.9990	2.0000	2.0014		ave	1.9999	1.9990	2.0000	2.0014		ave	1.9999	1.9990	2.0000	2.0014	
(47) Akyab, Burma																							
1979	1.9972	1.9987	2.0000	1.9991		Σ	30.0143	30.0245	29.9858	29.9777	Σ	1979	1.9972	1.9987	2.0000	1.9991		Σ	30.0143	30.0245	29.9858	29.9777	
1980	1.9967	2.0005	2.0014	2.0177	1.9938	1980	1.9967	2.0005	2.0014	2.0177	1.9938	1980	1.9967	2.0005	2.0014	2.0177	1.9938	1980	1.9967	2.0005	2.0014	2.0177	1.9938
1981	2.0000	1.9997	2.0016	2.0147		1981	2.0000	1.9997	2.0016	2.0147		1981	2.0000	1.9997	2.0016	2.0147		1981	2.0000	1.9997	2.0016	2.0147	
1982	1.9949	2.0019	2.0001	1.9983		1982	1.9949	2.0019	2.0001	1.9983		1982	1.9949	2.0019	2.0001	1.9983		1982	1.9949	2.0019	2.0001	1.9983	
1983	2.0027	1.9982	1.9990	2.0013		1983	2.0027	1.9982	1.9990	2.0013		1983	2.0027	1.9982	1.9990	2.0013		1983	2.0027	1.9982	1.9990	2.0013	
1984	1.9997	1.9991	2.0014	1.9981		1984	1.9997	1.9991	2.0014	1.9981		1984	1.9997	1.9991	2.0014	1.9981		1984	1.9997	1.9991	2.0014	1.9981	
1985	1.9972	2.0035	2.0009	1.9986	2.0011	1985	1.9972	2.0035	2.0009	1.9986	2.0011	1985	1.9972	2.0035	2.0009	1.9986	2.0011	1985	1.9972	2.0035	2.0009	1.9986	2.0011
1986	1.9975	1.9977	2.0013	1.9947		1986	1.9975	1.9977	2.0013	1.9947		1986	1.9975	1.9977	2.0013	1.9947		1986	1.9975	1.9977	2.0013	1.9947	
1987	1.9980	2.0049	2.0001	1.9965		1987	1.9980	2.0049	2.0001	1.9965		1987	1.9980	2.0049	2.0001	1.9965		1987	1.9980	2.0049	2.0001	1.9965	
1988	1.9967	2.0041	2.0019	1.9986		1988	1.9967	2.0041	2.0019	1.9986		1988	1.9967	2.0041	2.0019	1.9986		1988	1.9967	2.0041	2.0019	1.9986	
1989	1.9941	1.9997	2.0003	1.9989	1.9999	1989	1.9941	1.9997	2.0003	1.9989	1.9999	1989	1.9941	1.9997	2.0003	1.9989	1.9999	1989	1.9941	1.9997	2.0003	1.9989	1.9999
1990	1.9984	2.0006	1.9990	1.9987		1990	1.9984	2.0006	1.9990	1.9987		1990	1.9984	2.0006	1.9990	1.9987		1990	1.9984	2.0006	1.9990	1.9987	
1991	1.9984	2.0006	1.9989	1.9987		1991	1.9984	2.0006	1.9989	1.9987		1991	1.9984	2.0006	1.9989	1.9987		1991	1.9984	2.0006	1.9989	1.9987	
1992	2.0026	1.9997	1.9989	1.9989		1992	2.0026	1.9997	1.9989	1.9989		1992	2.0026	1.9997	1.9989	1.9989		1992	2.0026	1.9997	1.9989	1.9989	
1993	2.0009	1.9997	1.9989	1.9989		1993	2.0009	1.9997	1.9989	1.9989		1993	2.0009	1.9997	1.9989	1.9989		1993	2.0009	1.9997	1.9989	1.9989	
Σ	1.9984	2.0004	2.0017	1.9993		Σ	1.9984	2.0004	2.0017	1.9993		Σ	1.9984	2.0004	2.0017	1.9993		Σ	1.9984	2.0004	2.0017	1.9993	
ave	1.9999	2.0004	2.0012	1.9993		ave	1.9999	2.0004	2.0012	1.9993		ave	1.9999	2.0004	2.0012	1.9993		ave	1.9999	2.0004	2.0012	1.9993	
(48) Mexico City, Mexico																							
1979	2.0002	2.0023	2.0001	1.9963		Σ	31.9910	32.0121	32.0004	31.9923	Σ	1979	2.0002	2.0023	2.0001	1.9963		Σ	31.9910	32.0121	32.0004	31.9923	
1980	1.9986	2.0000	2.0034	1.9926	2.0002	1980	1.9986	2.0000	2.0034	1.9926	2.0002	1980	1.9986	2.0000	2.0034	1.9926	2.0002	1980	1.9986	2.0000	2.0034	1.9926	2.0002
1981	2.0013	1.9982	1.9980	2.0005		1981	2.0013	1.9982	1.9980	2.0005		1981	2.0013	1.9982	1.9980	2.0005		1981	2.0013	1.9982	1.9980	2.0005	
1982	1.9961	1.9981	2.0002	2.0077		1982	1.9961	1.9981	2.0002	2.0077		1982	1.9961	1.9981	2.0002	2.0077		1982	1.9961	1.9981	2.0002	2.0077	
1983	2.0026	1.9963	1.9935	2.0093		1983	2.0026	1.9963	1.9935	2.0093		1983	2.0026	1.9963	1.9935	2.0093		1983	2.0026	1.9963	1.9935	2.0093	
1984	2.0001	2.0002	2.0007	1.9970		1984	2.0001	2.0002	2.0007	1.9970		1984	2.0001	2.0002	2.0007	1.9970		1984	2.0001	2.0002	2.0007	1.9970	
1985	2.0003	1.9985	2.0001	2.0076		1985	2.0003	1.9985	2.0001	2.0076		1985	2.0003	1.9985	2.0001	2.0076		1985	2.0003	1.9985	2.0001	2.0076	
1986	1.9979	2.0019	2.0018	1.9976	2.0097	1986	1.9979	2.0019	2.0018	1.9976	2.0097	1986	1.9979	2.0019	2.0018	1.9976	2.0097	1986	1.9979	2.0019	2.0018	1.9976	2.0097
1987	2.0003	2.0008	1.9987	1.9962		1987	2.0003	2.0008	1.9987	1.9962		1987	2.0003	2.0008	1.9987	1.9962		1987	2.0003	2.0008	1.9987	1.9962	
1988	1.9923	2.0083	2.0071	1.9941		1988	1.9923	2.0083	2.0071	1.9941		1988	1.9923	2.0083	2.0071	1.9941		1988	1.9923	2.0083	2.0071	1.9941	
1989	1.9984	2.0007	2.0000	1.9987	1.9929	1989	1.9984	2.0007	2.0000	1.9987	1.9929	1989	1.9984	2.0007	2.0000	1.9987	1.9929	1989	1.9984	2.0007	2.0000	1.9987	1.9929
1990	2.0009	1.9977	2.0000	1.9987		1990	2.0009	1.9977	2.0000	1.9987		1990	2.0009	1.9977	2.0000	1.9987		1990	2.0009	1.9977	2.0000	1.9987	
1991	1.9984	2.0008	2.0016	1.9987		1991	1.9984	2.0008	2.0016	1.9987		1991	1.9984	2.0008	2.0016	1.9987		1991	1.9984	2.0008	2.0016	1.9987	
1992	1.9901	2.0070	2.0073	1.9985		1992	1.9901	2.0070	2.0073	1.9985		1992	1.9901	2.0070	2.0073	1.9985		1992	1.9901	2.0070	2.0073	1.9985	
1993	1.9901	2.0070	2.0073	1.9985		1993	1.9901	2.0070	2.0073	1.9985		1993	1.9901	2.0070	2.0073	1.9985		1993	1.9901	2.0070	2.0073	1.9985	
Σ	1.9984	2.0004	2.0017	1.9993		Σ	1.9984	2.0004	2.0017	1.9993		Σ	1.9984	2.0004	2.0017	1.9993		Σ	1.9984	2.0004	2.0017	1.9993	
ave	1.9999	2.0004	2.0012	1.9993		ave	1.9999	2.0004	2.0012	1.9993		ave	1.9999	2.0004	2.0012	1.9993		ave	1.9999	2.0004	2.0012	1.9993	
(49) Bombay, India																							
1979	2.0008	2.0008	1.9980	1.9978		Σ	31.9910	32.0121	32.0004	31.9923	Σ	1979	2.0008	2.0008	1.9980	1.9978		Σ	31.9910	32.0121	32.0004	31.9923	
1980	1.9986	2.0006	2.0000	1.9969	2.0001	1980	1.9986	2.0006	2.0000	1.9969	2.0001	1980	1.9986	2.0006	2.0000	1.9969	2.0001	1980	1.9986	2.0006	2.0000	1.9969	2.0001
1981	1.9982	2.0000	1.9980	2.0000		1981	1.9982</																

[illegible]

Base Year

1

2

3

4

Y222

88

Sarmiento, Argentina

1880

1.9852

2.0021

1.9879

2.0175

2.0357

1885

1.9852

2.0021

2.0005

2.0300

1890

1.9852

2.0038

1.9800

2.0287

1900

1.9852

2.0038

1.9800

2.0287

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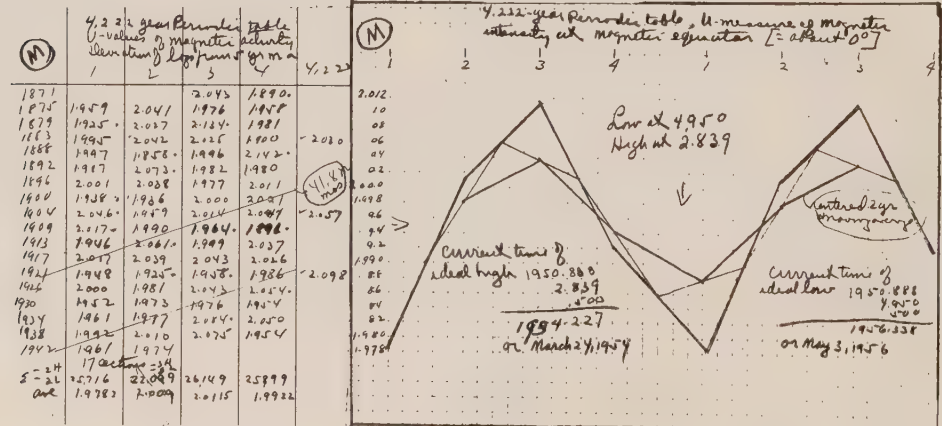
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APPENDIX 3



APPENDIX 2

